Instruction Manual

Models 7011-S and 7011-C

Quad 1 × 10 Multiplexer Cards

Contains Operating and Servicing Information

KEITHLEY

7011-901-01 Rev. C / 12-92

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During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

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Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 216-248-0400 • Fax: 216-248-6168 • http://www.keithley.com

CHINA:	**Keithley Instruments China** • Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-62022886 • Fax: 8610-62022892
FRANCE:	**Keithley Instruments SARL** • BP 60 • 3 Allée des Garays • 91122 Palaiseau Cédex • 33-1-60-11-51-55 • Fax: 33-1-60-11-77-26
GERMANY:	**Keithley Instruments GmbH** • Landsberger Strasse 65 • D-82110 Germering, Munich • 49-89-8493070 • Fax: 49-89-84930759
GREAT BRITAIN:	**Keithley Instruments, Ltd.** • The Minster • 58 Portman Road • Reading, Berkshire RG30 1EA • 44-118-9575666 • Fax: 44-118-9596469
ITALY:	**Keithley Instruments SRL** • Viale S. Gimignano 38 • 20146 Milano • 39-2-48303008 • Fax: 39-2-48302274
NETHERLANDS:	**Keithley Instruments BV** • Avelingen West 49 • 4202 MS Gorinchem • 31-(0)183-635333 • Fax: 31-(0)183-630821
SWITZERLAND:	**Keithley Instruments SA** • Kriesbachstrasse 4 • 8600 Dübendorf • 41-1-8219444 • Fax: 41-1-8203081
TAIWAN:	**Keithley Instruments Taiwan** • 1Fl., 1, Min Yu First Street • Hsinchu, Taiwan, R.O.C. • 886-35-778462 • Fax: 886-35-778455

Models 7011-S and 7011-C Instruction Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) measuring circuits are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The ⚠ symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The ⚠ symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean the instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument.

7011 SPECIFICATIONS

MODEL 7011-S Quad 1×10 Multiplexer with Screw Terminals.

MODEL 7011-C Quad 1×10 Multiplexer with Mass Terminated Connector.

MULTIPLEX CONFIGURATION: Four independent 1×10 2-pole Multiplex banks or two independent 1×10 4-pole Multiplex banks. Adjacent banks can be connected together. Jumpers can be removed to isolate any bank from the backplane.

CONTACT CONFIGURATION: 2-pole Form A (Hi, Lo).

CONNECTOR TYPE:

- **7011-S:** Screw terminal, #16AWG maximum wire size, with .092 inch O.D. 28 Conductors maximum. #22AWG typical wire size with .062 inch O.D. 88 Conductor maximum.
- **7011-C:** 96-Pin male Euro card connector. Mates to female twisted wire cable, crimp or solder connector.

MAXIMUM SIGNAL LEVEL:

- **DC Signals:** 110V DC between any two pins, 1A switched. 30VA (resistive load).
- **AC Signals:** 125V RMS or 175V AC peak, between any two pins, 1A switched, 60VA (resistive load).

COMMON MODE VOLTAGE: 175V peak, any pin to chassis.

CONTACT LIFE:

- **Cold Switching:** 10^8 closures.
- ***At Maximum Signal Levels:*** *10^5 closures.*

CHANNEL RESISTANCE (per conductor): < 1Ω.

CONTACT POTENTIAL:

- **7011-S:** < 500 nV per contact pair (Hi, Lo).
  < 1.5 μV per single contact.
- **7011-C:** < 1.5 μV per contact pair (Hi, Lo) (typically < 1 μV).
  < 3.5 μV per single contact (typically < 3 μV).

OFFSET CURRENT: < 100 pA.

ACTUATION TIME: 3 ms.

ISOLATION:

- **Bank:** $>10^9\Omega$, < 25 pF.
- **Channel to Channel:** $>10^9\Omega$, < 50 pF.
- **Differential:** Configured as 1×10 $>10^9\Omega$, < 100 pF.
  Configured as 1×40 $>10^9\Omega$, < 200 pF.
- **Common Mode:** Configured as 1×10 $>10^9\Omega$, < 200 pF.
  Configured as 1×40 $>10^9\Omega$, < 600 pF.

CROSS TALK (1MHz, 50Ω Load):

- **Bank:** < -40 dB.
- **Channel:** < -40 dB.

INSERTION LOSS (50Ω Source, 50 Load): < 0.1 dB below 1 MHz, < 3 dB below 2 MHz.

RELAY DRIVE CURRENT (per relay): 16 mA.

ENVIRONMENT:

- **Operation:** 0°C to 50°C, up to 35°C < 80% RH.
- **Storage:** -25°C to 65°C.

Specifications subject to change without notice.

7011 Quad 1x10 Multiplexer

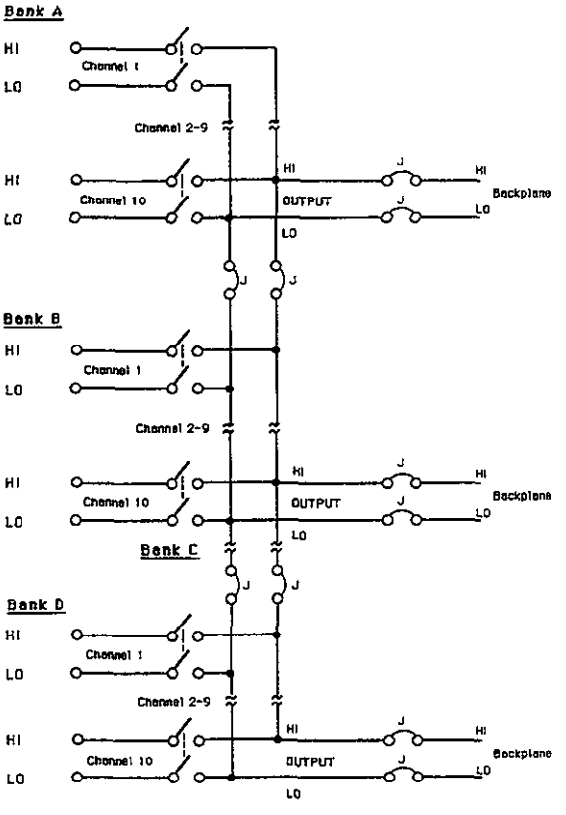


Table of Contents

1.1	Introduction	1-1
1.2	Features	1-1
1.3	Warranty information	1-2
1.4	Manual addenda	1-2
1.5	Safety symbols and terms	1-2
1.6	Specifications	1-2
1.7	Unpacking and inspection	1-2
1.7.1	Inspection for damage	1-2
1.7.2	Shipping contents	1-2
1.7.3	Instruction manual	1-3
1.7.4	Repacking for shipment	1-3
1.8	Optional accessories	1-3
2.1	Introduction	2-1
2.2	Basic multiplexer configurations	2-1
2.2.1	Multiplexer bank-to-bank jumpers	2-2
2.2.2	Backplane jumpers	2-5
2.3	Typical multiplexer switching schemes	2-6
2.3.1	Single-ended switching	2-7
2.3.2	Differential switching	2-7
2.3.3	Sensing	2-8
2.3.4	SMU connections	2-8
2.4	Multiplexer expansion	2-10
2.4.1	Two-card switching systems	2-10
2.4.2	Mainframe multiplexer expansion	2-11
3.1	Introduction	3-1
3.2	Handling precautions	3-1
3.3	Connections	3-1
3.3.1	Bank-to-bank jumpers	3-2
3.3.2	Backplane jumpers	3-3
3.3.3	Screw terminal connector card	3-4
3.3.4	Multi-pin (mass termination) connector card	3-6
3.4	Typical connection schemes	3-11
3.4.1	Single card system	3-11
3.4.2	Two-card system	3-14
3.4.3	Two-mainframe system	3-14
3.5	Model 7011 installation and removal	3-19

4.1 Introduction 4-1
4.2 Power limits 4-1
4.3 Mainframe control of multiplexer card 4-1
4.3.1 Channel assignments 4-2
4.3.2 Front panel control 4-4
4.3.3 IEEE-488 bus operation 4-4
4.4 Multiplexer switching examples 4-5
4.4.1 Resistor testing 4-5
4.4.2 Transistor testing 4-9
4.4.3 Testing with matrix cards 4-11
4.5 Measurement considerations 4-15
4.5.1 Path isolation 4-15
4.5.2 Magnetic fields 4-16
4.5.3 Radio frequency interference 4-16
4.5.4 Ground loops 4-17
4.5.5 Keeping connectors clean 4-17
4.5.6 AC frequency response 4-17

5.1 Introduction 5-1
5.2 Handling and cleaning precautions 5-1
5.3 Performance verification 5-2
5.3.1 Environmental conditions 5-2
5.3.2 Recommended equipment 5-2
5.3.3 Multiplexer card connections 5-3
5.3.4 Channel resistance tests 5-3
5.3.5 Offset current tests 5-5
5.3.6 Contact potential tests 5-7
5.3.7 Bank and channel-to-channel isolation tests 5-8
5.3.8 Differential and common-mode isolation tests 5-12
5.4 Special handling of static-sensitive devices 5-14
5.5 Principles of operation 5-15
5.5.1 Block diagram 5-15
5.5.2 ID data circuits 5-15
5.5.3 Relay control 5-17
5.5.4 Relay power control 5-17
5.5.5 Power-on safeguard 5-17
5.6 Troubleshooting 5-17
5.6.1 Troubleshooting equipment 5-17
5.6.2 Troubleshooting access 5-18
5.6.3 Troubleshooting Procedure 5-18

6.1 Introduction 6-1
6.2 Parts lists 6-1
6.3 Ordering information 6-1
6.4 Factory service 6-1
6.5 Component layouts and schematic diagrams 6-2

List of Illustrations

Figure 2-1 Model 7011 simplified schematic 2-2
Figure 2-2 Four 1 × 10 multiplexer configuration (jumpers not installed) 2-3
Figure 2-3 Two 1 × 20 multiplexer configuration (jumpers installed) 2-3
Figure 2-4 One 1 × 40 multiplexer configuration (jumpers installed) 2-4
Figure 2-5 Model 7001 analog backplane 2-5
Figure 2-6 Bank connections to backplane 2-6
Figure 2-8 Differential switching example 2-7
Figure 2-7 Single-ended switching example 2-7
Figure 2-9 Sensing example 2-8
Figure 2-10 SMU connections 2-9
Figure 2-11 Two separate multiplexer systems 2-10
Figure 2-12 Multiplexer input expansion example 2-11
Figure 2-13 Mixed card type example 2-12

Figure 3-1 Bank-to-bank jumper locations 3-2
Figure 3-2 Bank-to-bank jumper terminal identification 3-3
Figure 3-3 Bank-to-bank jumper installation 3-3
Figure 3-4 Backplane jumpers 3-4
Figure 3-5 Model 7011 screw terminal connector card 3-4
Figure 3-6 Typical screw terminal connections 3-5
Figure 3-7 Cable clamp for screw terminal connector card 3-5
Figure 3-8 Multi-pin card terminal identification 3-7
Figure 3-9 Typical round cable connection techniques 3-9
Figure 3-10 Model 7011-MTR connector pinout 3-10
Figure 3-11 Model 7011-KIT-R (with/cable) assembly 3-10
Figure 3-12 Single card system example (multi-pin connector card) 3-12
Figure 3-13 Single card system example (screw terminal connector card) 3-13
Figure 3-14 Two-card system example (multi-pin connector card) 3-15
Figure 3-15 Two-card system example (screw terminal connector card) 3-16
Figure 3-16 Two-mainframe system example (multi-pin connector card) 3-17
Figure 3-17 Two-mainframe system example (screw terminal connector card) 3-18
Figure 3-18 Model 7011-C card installation in Model 7001 3-20
Figure 3-19 7011-S card installation in Model 7001 3-21

Figure 4-1 Channel status display 4-2
Figure 4-2 Display organization for multiplexer channels 4-3
Figure 4-3 Model 7011 programming channel assignments 4-3
Figure 4-4 2-wire resistance testing 4-6

Figure 4-5 Four-wire resistance testing 4-7
Figure 4-6 Low resistance testing 4-8
Figure 4-7 Configuration for current gain and common-emitter test 4-10
Figure 4-8 Typical common-emitter characteristics 4-11
Figure 4-9 Connecting multiplexer and matrix cards together 4-12
Figure 4-10 Resistivity test configuration 4-13
Figure 4-11 Measurement required for resistivity test 4-14
Figure 4-12 Path isolation resistance 4-15
Figure 4-13 Voltage attenuation by path isolation resistance 4-16
Figure 4-14 Power line ground loops 4-17
Figure 4-15 Eliminating ground loops 4-17

Figure 5-1 Path resistance test connections 5-4
Figure 5-2 Differential offset current test connections 5-6
Figure 5-3 Contact potential test connections 5-7
Figure 5-4 Bank isolation test connections 5-8
Figure 5-5 Channel-to-channel isolation test connections 5-10
Figure 5-6 Differential isolation test connections 5-12
Figure 5-7 Common-mode isolation test connections 5-14
Figure 5-8 Model 7011 block diagram 5-15
Figure 5-9 Start and stop sequences 5-16
Figure 5-10 Transmit and acknowledge sequence 5-16

List of Tables

Table 3-1 Bank-to-bank jumpers (refer to Figure 3-2) 3-3
Table 3-2 Mass termination accessories 3-6

Table 4-1 Paired Channels in 4-pole Operation 4-6

Table 5-1 Verification equipment 5-2
Table 5-2 Bank isolation test summary 5-9
Table 5-3 Channel-to-channel isolation test summary 5-11
Table 5-4 Differential and common-mode isolation testing 5-13
Table 5-5 Recommended troubleshooting equipment 5-17
Table 5-6 Troubleshooting procedure 5-19

1

General Information

1.1 Introduction

This section contains general information about the Model 7011 Quad 1 × 10 Multiplexer card.

There are two basic versions of this multiplexer card; the Model 7011-S and the Model 7011-C. The Model 7011-S assembly consists of a screw terminal connector card and a relay card. External test circuits are wired directly to the screw terminals of the connector card. Also available from Keithley is the Model 7011-ST. This is an extra screw terminal connector card. With an extra connector card, you can wire a second test system without disturbing the wiring configuration of the first test system.

The Model 7011-C assembly consists of a multi-pin (mass termination) connector card and the relay card. External test circuit connections to the multiplexer are made via the 96-pin male DIN connector on the connector card. Keithley offers a variety of optional accessories that can be used to make connections to the connector card (see paragraph 1.9).

The rest of Section 1 is arranged in the following manner:

1.2 Features

1.3 Warranty information

1.4 Manual addenda

1.5 Safety symbols and terms

1.6 Specifications

1.7 Unpacking and inspection

1.8 Repacking for shipment

1.9 Optional accessories

1.2 Features

The Model 7011 is a low voltage, two-pole, quad, 1 × 10 multiplexer card. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.
- The connector board detaches from the relay board allowing easy access to the screw terminals (Model 7011-S) and jumpers.
- Easy jumper configuration of one, two, three or four multiplexer banks.
- Backplane jumpers. Cutting jumpers disconnects multiplexer bank outputs from the Model 7001 analog backplane.

1.3 Warranty information

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7011 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the multiplexer card for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4 Manual addenda

Any improvements or changes concerning the multiplexer card or manual will be explained in an addendum included with the card. Addenda are provided in a page replacement format. Simply replace the obsolete pages with the new pages.

1.5 Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the instruction manual.

The symbol on an instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the multiplexer card. Such damage may invalidate the warranty.

1.6 Specifications

Model 7011 specifications are found at the front of this manual. These specifications are exclusive of the multiplexer mainframe specifications.

1.7 Unpacking and inspection

1.7.1 Inspection for damage

The Model 7011 is packaged in a re-sealable, anti-static bag to protect it from damage due to static discharge and from contamination that could degrade its performance. Before removing the card from the bag, observe the following precautions on handling.

Handling Precautions:

1. Always grasp the card by the side edges and shields. Do not touch the board surfaces or components.
2. When not installed in a Model 7001 mainframe, keep the card in the anti-static bag and store it in the original packing carton.

After removing the card from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.

1.7.2 Shipping contents

The following items are included with every Model 7011 order:

- Model 7011 Quad 1 × 10 Multiplexer Card
- Model 7011 Instruction Manual
- Additional accessories as ordered

1.7.3 Instruction manual

The Model 7011 Instruction Manual is three-hole drilled so that it can be added to the three-ring binder of the Model 7001 Instruction Manual. After removing the plastic wrapping, place the manual in the binder following the mainframe instruction manual. Note that a manual identification tab is included and should precede the multiplexer card instruction manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7011-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.7.4 Repacking for shipment

Should it become necessary to return the Model 7011 for repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Advise as to the warranty status of the multiplexer card.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of this manual.

1.8 Optional accessories

The following accessories are available for use with the Model 7011:

Model 7011-ST — This screw terminal connector card is identical to the one provided with the Model 7011-S assembly. An extra screw terminal connector card allows you to wire a second test system without disturbing the wiring configuration of the first connector card.

Model 7011-KIT-R — This connection kit includes a 96-pin female DIN connector that will mate directly to the connector on the Model 7011-C or to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR). This connector uses solder cups for connections to external circuitry. It includes an adapter for a round cable and the housing.

Model 7011-MTC-2 — This 2-meter round cable assembly is terminated with a 96-pin female DIN connector on each end. It will mate directly to the connector on the Model 7011-C and to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR).

Model 7011-MTR — This 96-pin male DIN bulkhead connector uses solder cups for connections to external circuitry. It will mate to the Model 7011-KIT-R connector, and Model 7011-MTC-2 cable assembly.

2

Multiplexing Basics

2.1 Introduction

This section covers the basics for multiplex switching and is arranged as follows:

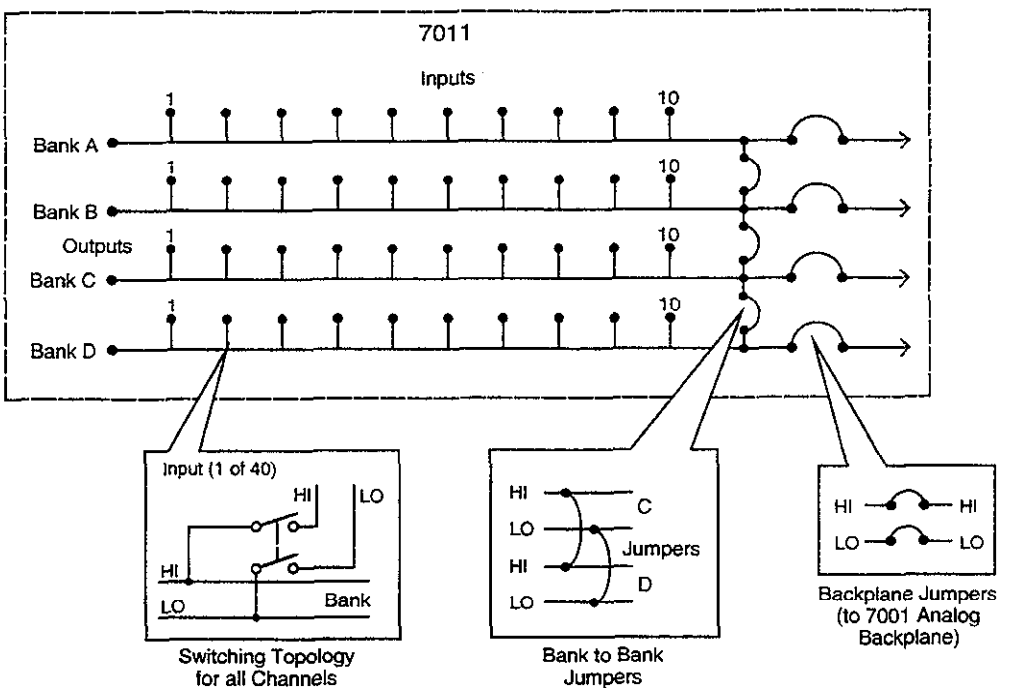
2.2 **Basic multiplex configurations:** Covers the basic multiplex configurations; quad 1 × 10 configuration, dual 1 × 20 configuration and single 1 × 40 configuration. The significance of the backplane jumpers is also covered here.

2.3 **Typical multiplex switching schemes:** Explains some of the basic ways a multiplexer can be used to source or measure. Covers single-ended switching, differential (floating) switching and sensing.

2.4 **System expansion:** Discusses the various configurations that are possible by using multiple cards.

2.2 Basic multiplexer configurations

A simplified schematic of the Model 7011 multiplexer is shown in Figure 2-1. It is organized as four 1 × 10 multiplexer banks. Each bank has 10 inputs and one output. Two-pole switching is provided for each multiplexer input, with HI and LO switched. Two or more banks can be jumpered together to expand multiplexer inputs, and backplane jumpers provide bank connections to a second card installed in Model 7001 mainframe.



Note : Factory Configuration shown

Figure 2-1
Model 7011 simplified schematic

2.2.1 Multiplexer bank-to-bank jumpers

Jumpers are installed on the connector card to connect multiplexer banks together to form a multiplexer of 1 × 40. Each jumper set connects two adjacent banks together. These jumper sets are included with the Model 7011.

The bank-to-bank jumpers allow you to configure the multiplexer card in a variety of ways. Typical multiplexer configurations include:

- Four 1 × 10 multiplexers; no jumpers installed (Figure 2-2).
- Two 1 × 20 multiplexers; Bank A jumpered to Bank B, Bank C jumpered to Bank D (Figure 2-3).
- One 1 × 40 multiplexer; all bank-to-bank jumpers installed (Figure 2-4).

Other combinations are possible, including multiplexers of various sizes (in multiples of 10 channels). For example, you could install jumpers to configure the card as one 1 × 30 and one 1 × 10 multiplexer.

Refer to Section 3 for information on installing bank-to-bank jumpers.

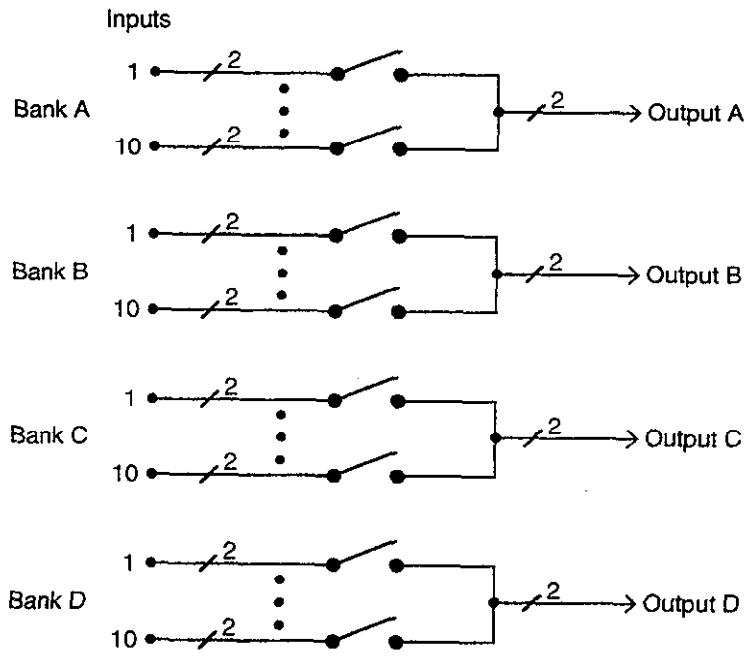


Figure 2-2
Four 1 x 10 multiplexer configuration (jumpers not installed)

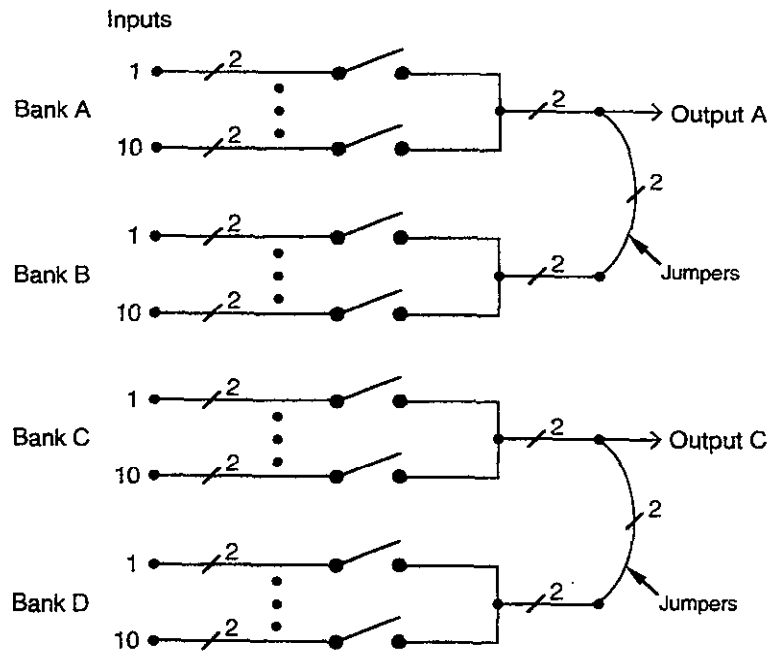


Figure 2-3
Two 1 x 20 multiplexer configuration (jumpers installed)

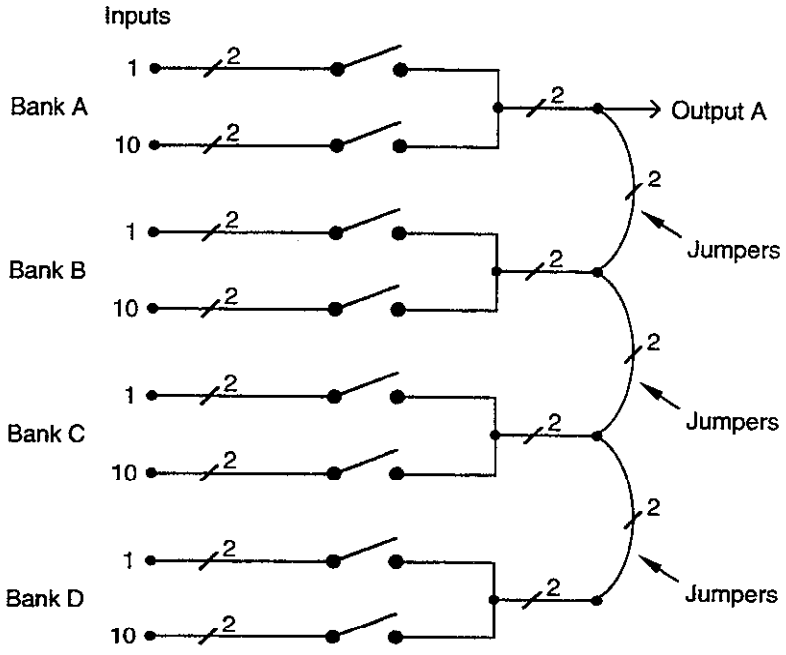


Figure 2-4
One 1 × 40 multiplexer configuration (jumpers installed)

2.2.2 Backplane jumpers

There are four pairs of backplane jumpers located on the relay card. With the jumpers installed, the banks of the multiplexer card are connected to the analog backplane of the Model 7001 allowing expansion with a second 7001 card installed in the mainframe. With the jumpers removed (cut), the multiplexer card is isolated from another card installed in the mainframe.

The three-pole analog backplane of the Model 7001 mainframe is shown in Figure 2-5. Through this analog backplane the banks of a Model 7011 multiplexer card, installed in one slot, can be connected to the banks (or rows) of a compatible card installed in the other slot of the mainframe.

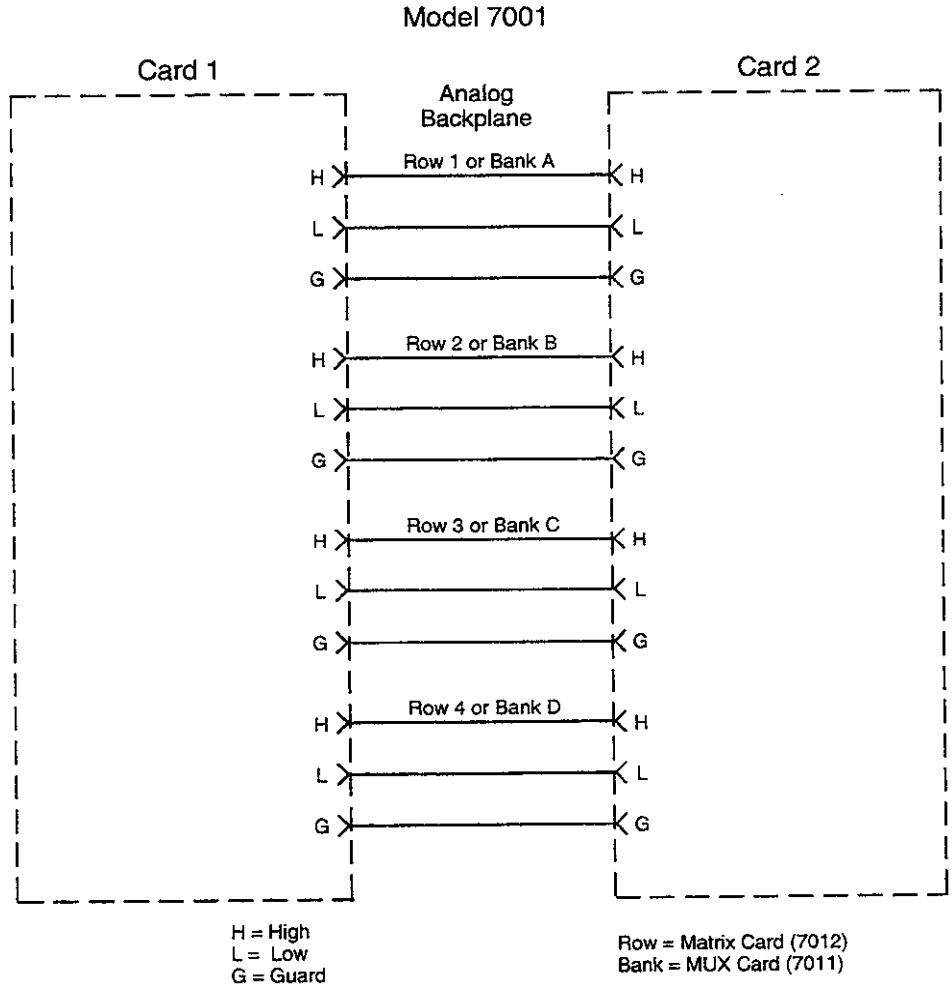


Figure 2-5
Model 7001 analog backplane

Figure 2-6 shows how each bank of the Model 7011 is connected to the backplane. Notice that since the Model 7011 is a two-pole card, there is no connection made to the Guard terminal of the backplane. The Model 7011 is shipped from the factory with the backplane jumpers installed.

Removing (cutting) the backplane jumpers isolates the card from the backplane, and subsequently, any card installed in the other slot. For information on removing the jumpers, refer to Section 3.

NOTE

The Model 7001 does not provide an analog backplane for the non-701X series cards. As a result, any of these cards installed in one slot in the mainframe is electrically isolated from any card installed in the other slot. The only way to connect a Model 7011 to one of these cards is to wire them together.

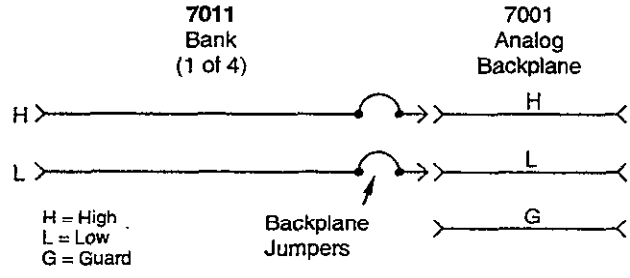


Figure 2-6
Bank connections to backplane

2.3 Typical multiplexer switching schemes

The following paragraphs describe some basic switching schemes that are possible with a two-pole switching multiplexer. These switching schemes include some various shielding configurations to help minimize noise pick up in sensitive measurement applications. These shields are shown connected to chassis ground. For some test configurations, shielding may prove to be more effective connected to circuit common. Chassis ground is accessible at the rear panel of the Model 7001.

2.3.1 Single-ended switching

In the single-ended switching configuration, the source or measure instrument is connected to the DUT through a single pathway as shown in Figure 2-7. The instrument is connected to the output of one of the banks and the DUT is shown connected to one of the inputs for that bank.

2.3.2 Differential switching

The differential or floating switching configuration is shown in Figure 2-8. The advantage of using this configuration is that the terminals of the source or measure instrument are not confined to the same pathway. Each terminal of the instrument can be switched to any available input in the test system.

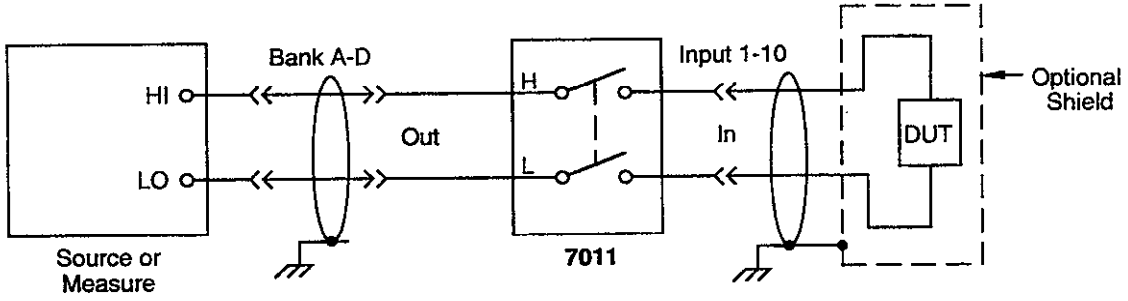


Figure 2-7
Single-ended switching example

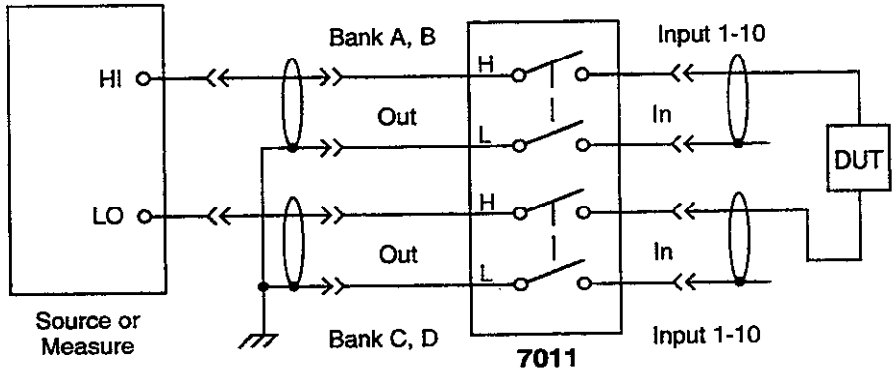


Figure 2-8
Differential switching example

2.3.3 Sensing

Figure 2-9 shows how the multiplexer card can be configured to use instruments that have sensing capability. The main advantage of using sensing is to cancel the effects of switch card path resistance (<1Ω) and the resistance of external cabling. Whenever path resistance is a consideration, sensing should be used.

2.3.4 SMU connections

Figure 2-10 shows how to connect a Keithley Model 236, 237 or 238 Source Measure Unit to the multiplexer card. By using triax cables that are unterminated at one end, the driven guard and chassis ground are physically extended all the way to the card.

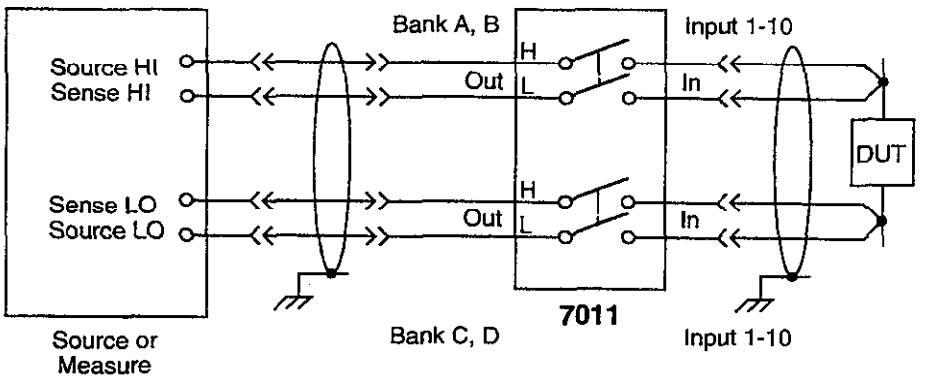
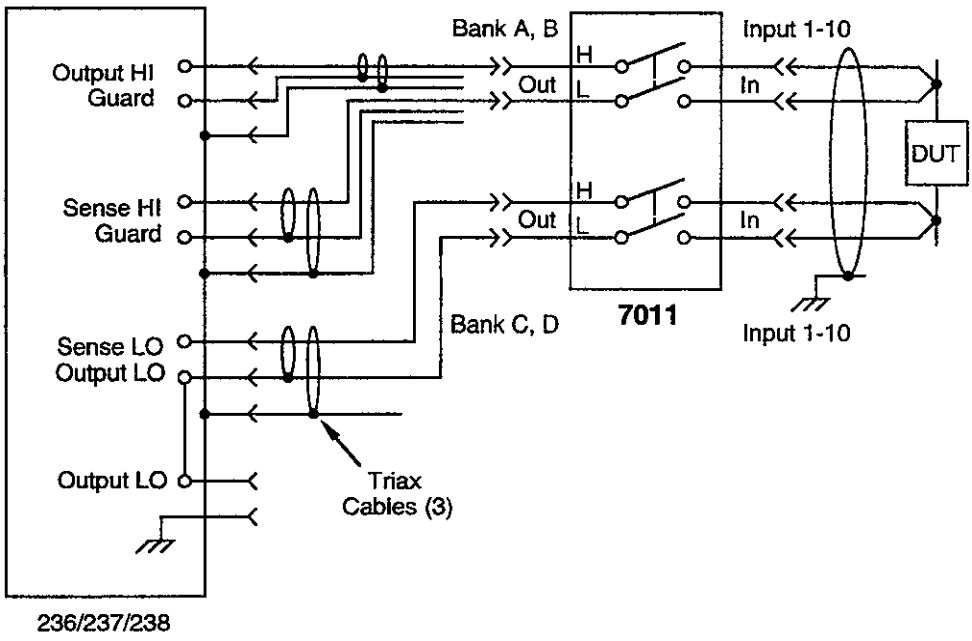


Figure 2-9
Sensing example



WARNING : Hazardous voltages may be present on GUARD. Make sure all cable shields are properly insulated before applying power.

Figure 2-10
SMU connections

2.4 Multiplexer expansion

With the use of additional switching cards and mainframes, larger systems can be configured. Each Model 7001 Switch System mainframe will accommodate up to two cards, and up to six mainframes can be connected together. Thus, a switch system using as many as 12 cards can be configured.

2.4.1 Two-card switching systems

Each Model 7001 Switch System mainframe can accommodate two cards to allow the following switching configurations.

Separate switching systems

Two single-card systems can be configured by removing the backplane jumpers from one of the cards. The two cards will be controlled by the same mainframe, but they will be electrically isolated from each other. Figure 2-11 shows an example using two Model 7011 multiplexer cards.

Multiplexer input expansion

You can double the number of multiplexer inputs by simply installing two "as shipped" Model 7011s in the Model 7001 mainframe. By leaving the backplane jumpers installed, the banks of the multiplexer card installed in slot 1 (CARD 1) are automatically connected to the banks of the multiplexer card installed in slot 2 (CARD 2) through the analog backplane.

Figure 2-12 shows an example of input expansion. Each Model 7011 card is configured as four 1 × 10 multiplexers. By connecting the banks together (via Model 7001 analog backplane), the resultant multiplexer system has 20 inputs for each of the four banks. Notice that if all the bank-to-bank jumpers (for both cards) were installed, the result would be a single 1 × 80 multiplexer.

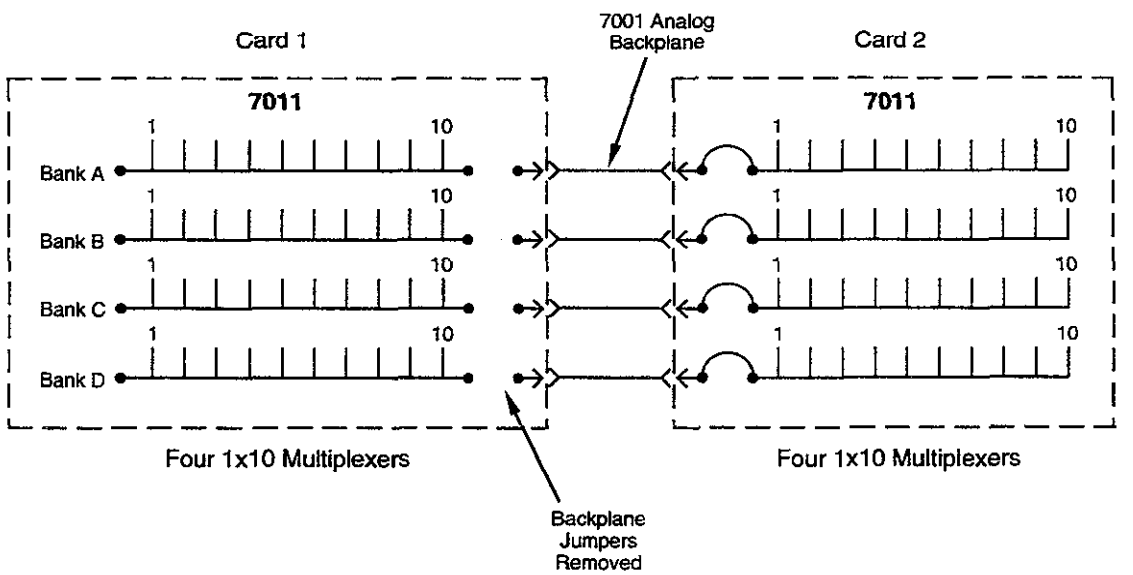


Figure 2-11
Two separate multiplexer systems

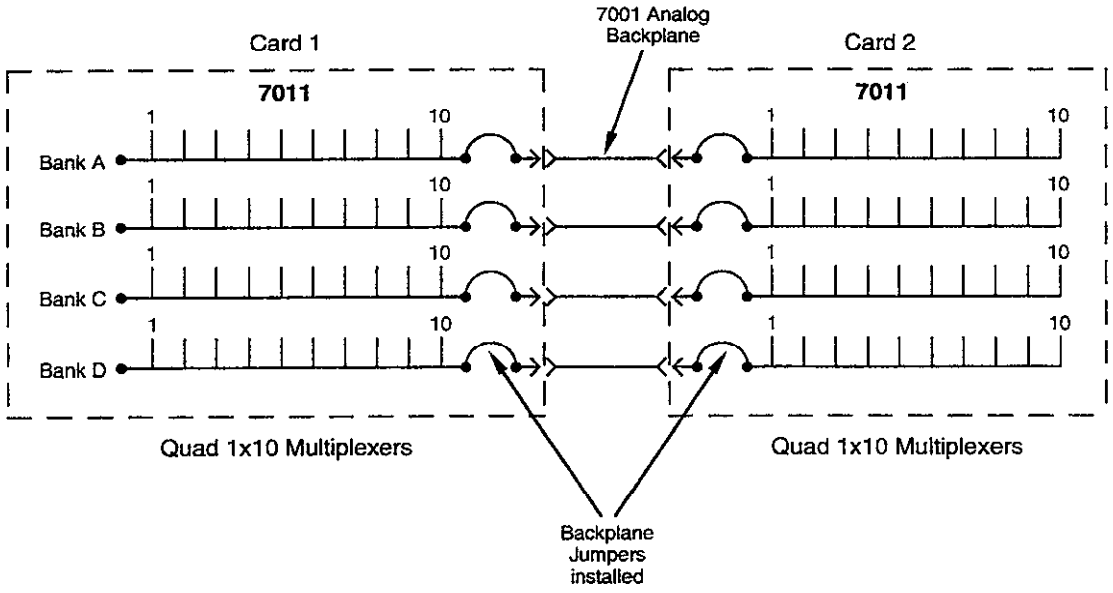


Figure 2-12
Multiplexer input expansion example

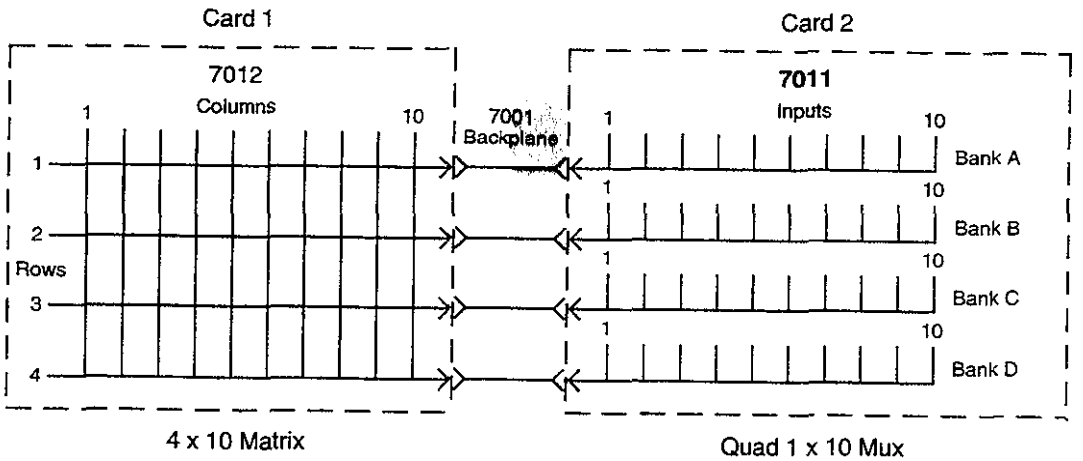
Mixing card types

Different types of cards can be used together to create some unique switching systems. For example, you could have a Model 7011 multiplexer card installed in one slot and a Model 7012 matrix card installed in the other slot.

Figure 2-13 shows a possible switching system using a matrix card and a multiplexer card. The backplane jumpers for both the matrix and multiplexer cards must be installed. This allows matrix rows to be connected to multiplexer banks. On the multiplexer card, the bank-to-bank jumpers must be removed to maintain isolation between matrix rows. See the instruction manual for the Model 7012 for complete information on the matrix card.

2.4.2 Mainframe multiplexer expansion

Multiplexer systems using up to 12 multiplexer cards are possible by using six Model 7001 mainframes together. Each Model 7011 added to the system provides 40 additional inputs. Paragraph 3.4.3 explains how to connect a test system using two mainframes.



Notes : 1. Models 7011 and 7012 backplane jumpers must be installed.
2. Model 7011 bank-to-bank jumpers must be removed.

Figure 2-13
Mixed card type example

3

Card Connections & Installation

3.1 Introduction

WARNING

The procedures in this section are intended only for qualified service personnel. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

The information in this section is arranged as follows:

3.2 **Handling precautions:** Explains precautions that must be followed to prevent contamination to the multiplexer card assembly. Contamination could degrade the performance of the multiplexer card.

3.3 **Connections:** Covers the basics for connecting external circuitry to the two available connector cards for the multiplexer; the screw terminal connector card and the multi-pin connector card.

3.4 **Typical connection schemes:** Provides some typical connection schemes for single card, two-card and two-mainframe system configurations.

3.5 **Model 7011 installation:** Provides a procedure to install the multiplexer card assembly in the Model 7001 mainframe.

3.2 Handling precautions

To maintain high impedance isolation, care should be taken when handling the relay card to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistances, thus degrading performance.

To avoid possible contamination, always grasp the relay and connector cards by the side edges or shields. Do not touch the board surfaces or components. On connectors, do not touch areas adjacent to the electrical contacts. Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and multiplexer card in a clean environment.

If a card becomes contaminated, it should be thoroughly cleaned as explained in paragraph 5.2.

3.3 Connections

This paragraph provides the basic information needed to connect your external test circuitry to the multiplexer. It includes the installation of the bank-to-bank jumpers on the connector card, installation/removal of backplane jumpers on the relay card, and detailed in-

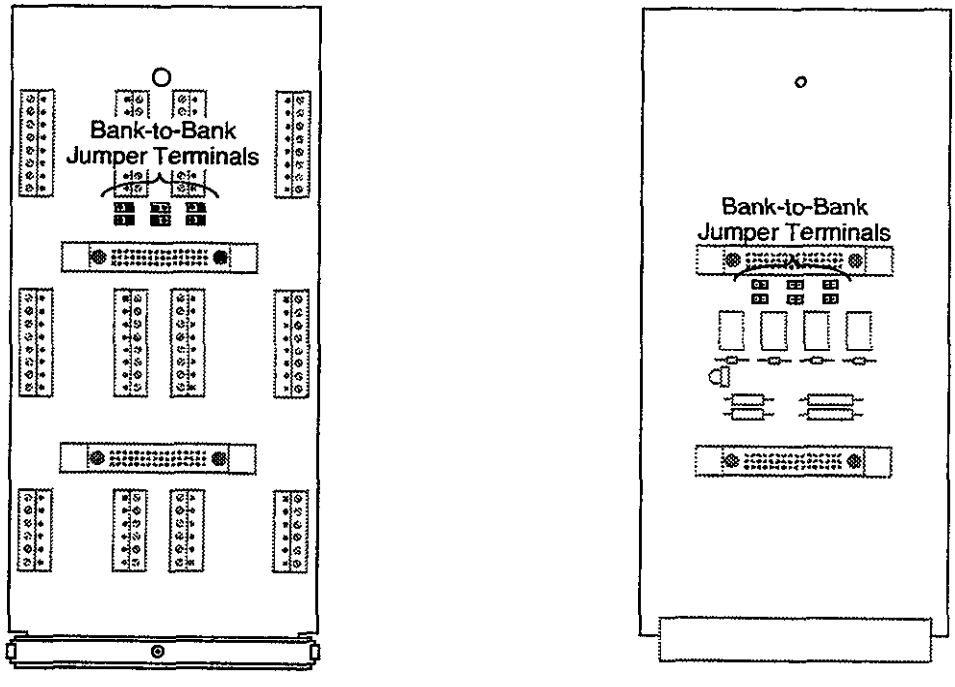
formation on making external connections to the two available connector cards.

WARNING

The following connection information is intended to be used by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

3.3.1 Bank-to-bank jumpers

As explained in paragraph 2.2.1, the banks of the multiplexer card can be connected together (using plug-in jumpers) to form larger multiplexers. The locations of the bank-to-bank jumper terminals for both connector cards are shown in Figure 3-1.



A. Screw Terminal Connector Card

B. Multi-pin Connector Card

Figure 3-1
Bank-to-bank jumper locations

Terminal identification is provided by Figure 3-2. On the drawing, the six terminal pairs are labeled W100 through W105. The top three terminal pairs (W101, W103 and W105) are used to connect the LO terminals of the banks together. The bottom terminal pairs (W100, W102 and W104) are used to connect the HI terminals of the banks together. Table 3-1 summarizes the effects of each jumper.

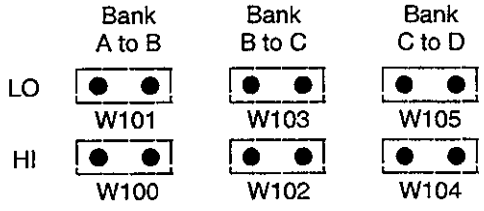


Figure 3-2
Bank-to-bank jumper terminal identification

Table 3-1
Bank-to-bank jumpers (refer to Figure 3-2)

Installed jumper	Effect
W101 W100	Connect Bank A LO to Bank B LO Connect Bank A HI to Bank B HI
W103 W102	Connect Bank B LO to Bank C LO Connect Bank B HI to Bank C HI
W105 W104	Connect Bank C LO to Bank D LO Connect Bank C HI to Bank D HI

Referring to Figure 3-1 for jumper locations, perform the following steps to install bank-to-bank jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Refer to Figure 3-2 and Table 3-1 to determine which jumpers to install.
3. Using Figure 3-3 as a guide, install the jumpers on the appropriate terminal pairs.

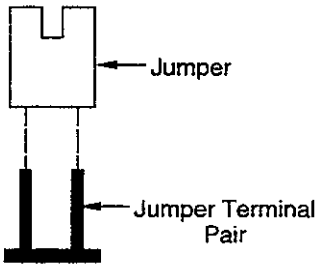


Figure 3-3
Bank-to-bank jumper installation

3.3.2 Backplane jumpers

The Model 7001 mainframe has an analog backplane that allows the banks of a Model 7011 multiplexer to be internally connected to a compatible switching card installed in the other slot (see paragraph 2.4.1 for details).

The backplane jumpers for the multiplexer card assembly are located on the relay card as shown in Figure 3-4. The card is shipped from the factory with the jumpers installed.

Jumper removal

Perform the following steps to remove backplane jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Use Figure 3-4 to locate the jumper(s) that are to be removed.
3. It is not necessary to physically remove the jumpers from the PC board. Using a pair of wire cutters, cut one lead of each jumper.

:umper installation

Referring to Figure 3-4 for jumper locations, perform the following steps to install backplane row jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Physically remove a cut jumper by unsoldering it from the PC board.
3. Install a new #22 AWG jumper wire (Keithley P/N J-15) and solder it to the PC board.
4. Remove the solder flux from the PC board The cleaning procedure is explained in paragraph 5.2.

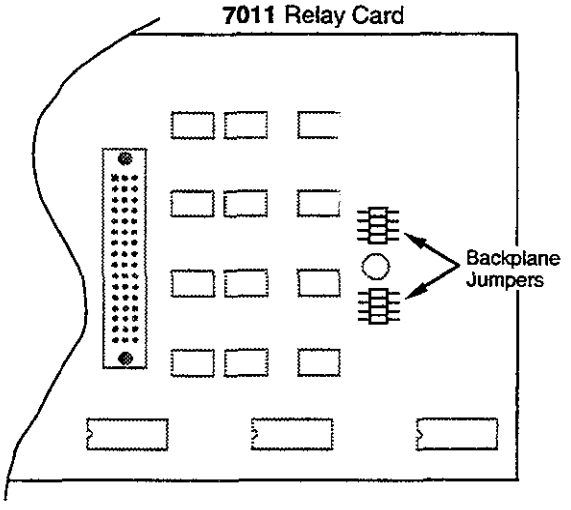


Figure 3-4
Backplane jumpers

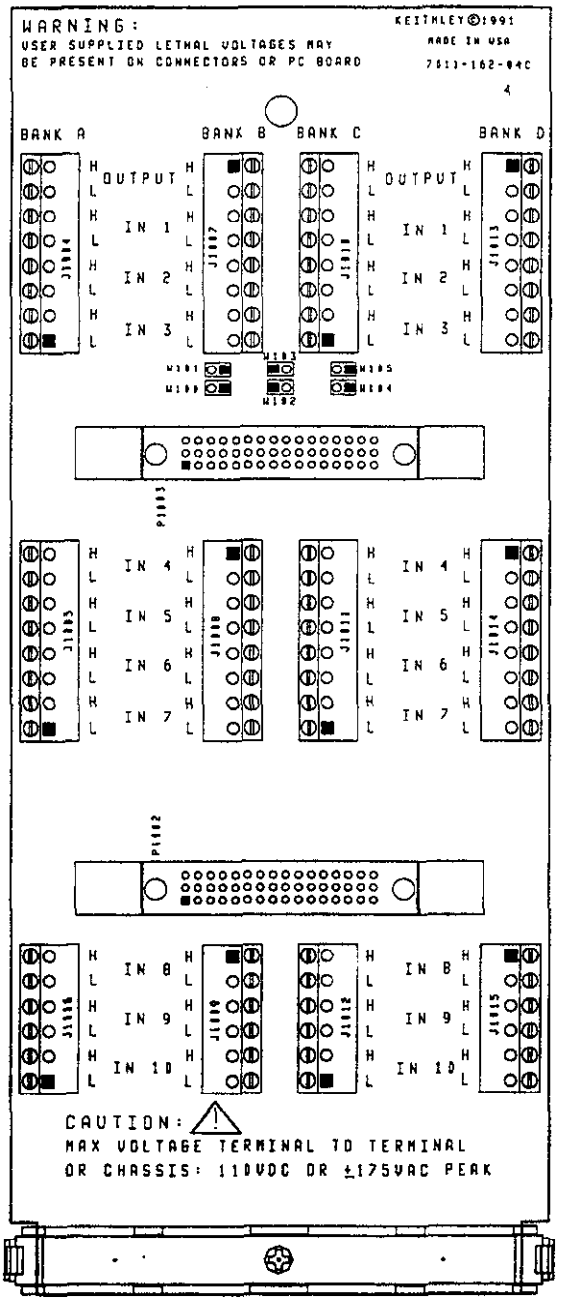


Figure 3-5
Model 7011 screw terminal connector card

3.3.3 Screw terminal connector card

The screw terminal connector card is shown in Figure 3-5. Connections are made directly to the screw terminals of the twelve terminal blocks. Each screw terminal will accommodate #16-22 AWG wire.

Wiring procedure

Perform the following procedure to wire circuitry to the screw terminal connector card:

WARNING

Make sure all power is off and any stored energy in external circuitry is discharged.

1. If mated together, separate the connector card from the relay card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Using an insulated screwdriver, connect the circuitry to the appropriate terminals. Figure 3-6 shows how the output of Bank A would be connected to a DMM.
3. Referring to Figure 3-7, remove the top half of the cable clamp as follows:
   A. Loosen the cable clamp screw enough to disengage it from the bottom half of the cable clamp.
   B. Using your thumb and forefinger, press the retaining clips inward and, with your other hand, remove the top half of the clamp.
4. Route wires under wire guide/connector shim.
5. Route the wires through the bottom half of the cable clamp.
6. Replace the top half of the clamp. It simply snaps onto the bottom half of the clamp. Tighten the cable clamp screw. The clamp serves as a strain relief for terminal block wires.
7. Mate the connector card to the relay card. The Model 7011 is now ready to be installed in the Model 7001 mainframe. See paragraph 3.5 for details.

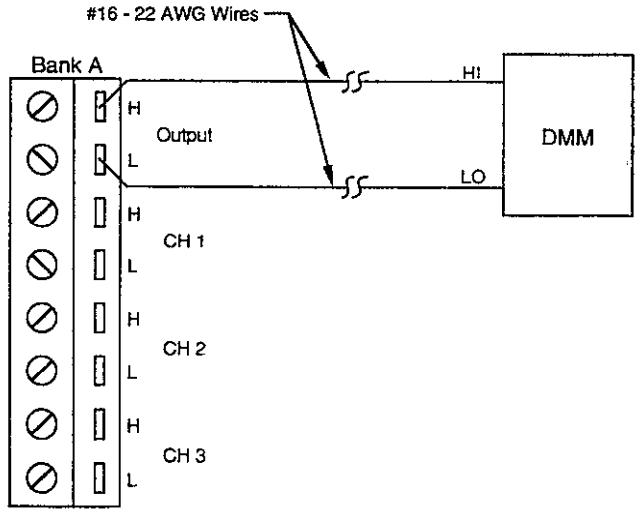


Figure 3-6
Typical screw terminal connections

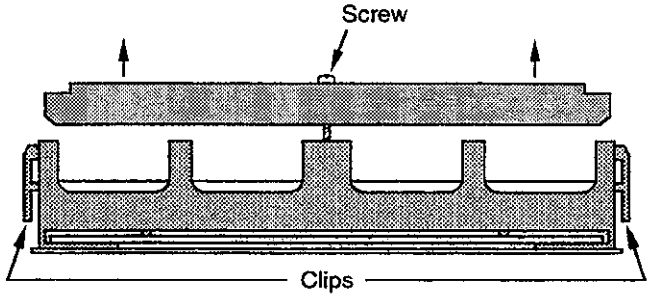


Figure 3-7
Cable clamp for screw terminal connector card

3.3.4 Multi-pin (mass termination) connector card

Since connections to external circuitry are made at the 96-pin male DIN bulkhead connector, there is no need to separate the connector card from the relay card. If the connector card is separated from the relay card, carefully mate them together and install the supplied 4-40 mounting screw. Make sure to handle the cards by the edges and shields to avoid contamination.

Terminal identification for the DIN connector of the multi-pin connector card is provided by Figure 3-8. This connector will mate to a 96-pin female DIN connector.

Keithley has a variety of cable and connector accessories available to accommodate connections from the connector card to test instrumentation and DUT (devices under test). In general, these accessories, which are summarized in Table 3-2, utilize a round cable assembly for connections.

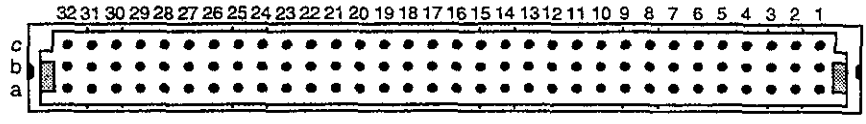
Table 3-2
Mass termination accessories

Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable.
7011-MTC-2	Two-meter round cable assembly terminated with a 96-pin female DIN connector on each end.
7011-MTR	96-pin male DIN bulkhead connector.

Pins of the Model 7011-C mass termination connector can be identified in one of three ways:

1. Mux terminal, consisting of banks A-D and inputs 1-10.
2. Connector description, consisting of rows a-c and columns 1-32.
3. Schematic and component layout designation (1-96).

The following pinout diagrams show the correspondence between these arrangements:



View from pin side of connector

Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96
Bank A				Bank B				Bank C				Bank D			
Input 1	HI	32c	96	Input 1	HI	24c	88	Input 1	HI	16c	80	Input 1	HI	8c	72
	LO	32b	64		LO	24b	56		LO	16b	48		LO	8b	40
Input 2	HI	32a	32	Input 2	HI	24a	24	Input 2	HI	16a	16	Input 2	HI	8a	8
	LO	31c	95		LO	23c	87		LO	15c	79		LO	7c	71
Input 3	HI	31b	63	Input 3	HI	23b	55	Input 3	HI	15b	47	Input 3	HI	7b	39
	LO	31a	31		LO	23a	23		LO	15a	15		LO	7a	7
Input 4	HI	30c	94	Input 4	HI	22c	86	Input 4	HI	14c	78	Input 4	HI	6c	70
	LO	30b	62		LO	22b	54		LO	14b	46		LO	6b	38
Input 5	HI	30a	30	Input 5	HI	22a	22	Input 5	HI	14a	14	Input 5	HI	6a	6
	LO	29c	93		LO	21c	85		LO	13c	77		LO	5c	69
Input 6	HI	29b	61	Input 6	HI	21b	53	Input 6	HI	13b	45	Input 6	HI	5b	37
	LO	29a	29		LO	21a	21		LO	13a	13		LO	5a	5
Input 7	HI	28c	92	Input 7	HI	20c	84	Input 7	HI	12c	76	Input 7	HI	4c	68
	LO	28b	60		LO	20b	52		LO	12b	44		LO	4b	36
Input 8	HI	28a	28	Input 8	HI	20a	20	Input 8	HI	12a	12	Input 8	HI	4a	4
	LO	27c	91		LO	19c	83		LO	11c	75		LO	3c	67
Input 9	HI	27b	59	Input 9	HI	19b	51	Input 9	HI	11b	43	Input 9	HI	3b	35
	LO	27a	27		LO	19a	19		LO	11a	11		LO	3a	3
Input 10	HI	26c	90	Input 10	HI	18c	82	Input 10	HI	10c	74	Input 10	HI	2c	66
	LO	26b	58		LO	18b	50		LO	10b	42		LO	2b	34
Output	HI	26a	26	Output	HI	18a	18	Output	HI	10a	10	Output	HI	2a	2
	LO	25c	89		LO	17c	81		LO	9c	73		LO	1c	65

Notes: 1. Pins 9a and 9b (pins 9 and 41 on schematic) are shield.
2. Short pins 1a to 1b on the mating connector (pins 1 and 33 on schematic) to allow the output relays on the connector card to close.

Figure 3-8
Multi-pin card terminal identification

Typical connection techniques

All external circuitry, such as instrumentation and DUTs, that you wish to connect to the multiplexer card must be terminated with a single 96-pin female DIN connector. The following connection techniques provide some guidelines and suggestions for wiring your circuitry.

WARNING

Before beginning any wiring procedures, make sure all power is off and any stored energy in external circuitry is discharged.

NOTE

External circuitry should be connected (wired in) only with the 7001's power off after the Model 7011 assembly is installed in the Model 7001 mainframe. Installation is covered in paragraph 3.5.

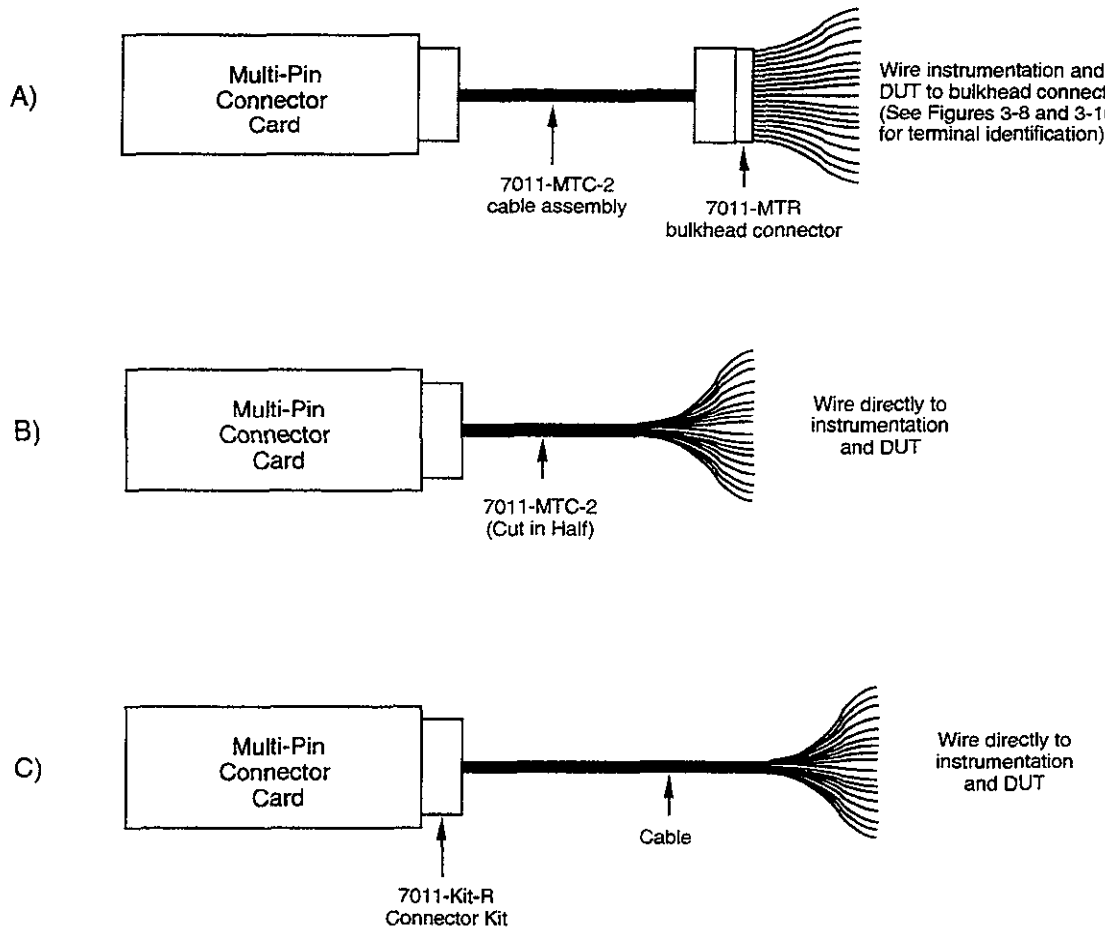
Output relays— The multi-pin connector card uses a relay for each of the four output banks. These output relays are normally open to prevent any hazardous voltages (via the mainframe backplane) from appearing on the pins of the male DIN connector. The output relays will only close when the Model 7011-MTC-2 cable assembly is connected to card. If building you own cable assembly, you must make sure that it shorts pins 1a to 1b of the card connector (Figure 3-8) when it is mated to the card. Shorting pins 1a to 1b allows the output relays to close.

Round cable assemblies — Figure 3-9 shows typical round cable connection techniques using accessories available from Keithley.

In Figure 3-9A, connections are accomplished using a Model 7011 MTC-2 cable and a Model 7011-MTR bulkhead connector. The two-meter round cable is terminated with a 96-pin female DIN connector at each end. This cable mates directly to the multi-pin connector card and to the bulkhead connector. The bulkhead connector has solder cups to allow direct connection to instrumentation and DUT. Figure 3-10 provides the pinout for the bulkhead connector.

In Figure 3-9B, connections are accomplished using a Model 7011 MTC-2 cable assembly that is cut in half. The 96-pin female DIN connector on one end of the cable mates directly to the multi-pin connector card. The unterminated end of the cable is wired directly to instrumentation and DUT. The other half of the cable assembly could be used for a second switching card.

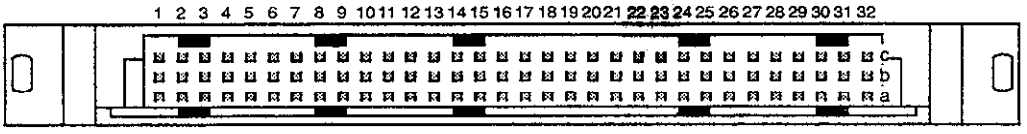
In Figure 3-9C, connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi cable part number N2807-P/D-50TAB is a 50-conductor cable. Two of these cables can be used to supply 100 conductors.The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 3-11 provides an exploded view of the connector assembly and shows how the cable is connected. The connector end of the resultant cable assembly mates directly to the multi-pin connector card. The unterminated end of the cable assembly is wired directly to instrumentation and DUT.



Notes : Figure 3-11 provides an exploded view showing how the connector (with cable) is assembled.

Cable Hitachi p/n N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to supply 100 conductors.

Figure 3-9
Typical round cable connection techniques



Note : See Figure 3-8 for terminal identification.

Figure 3-10
Model 7011-MTR connector pinout

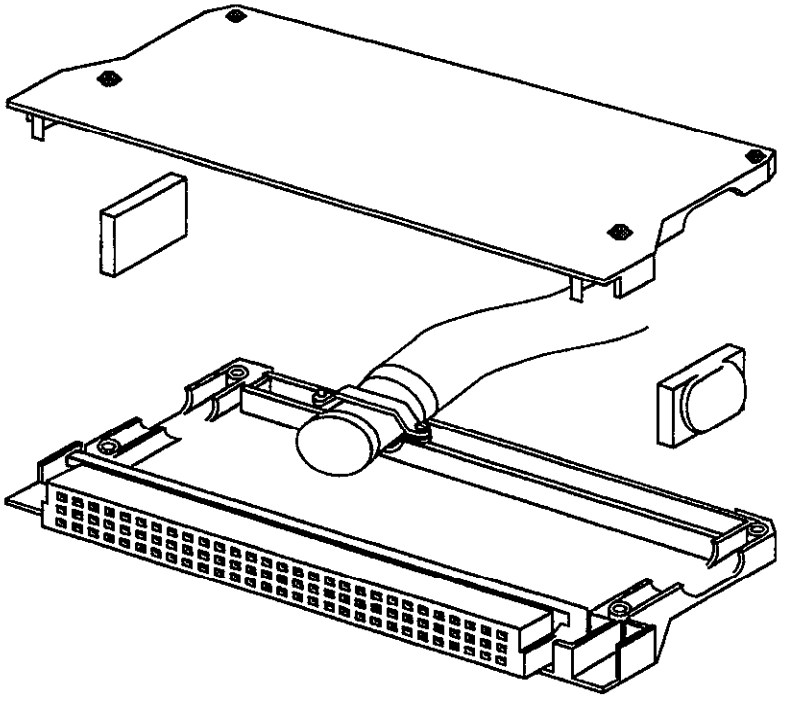


Figure 3-11
Model 7011-KIT-R (with/cable) assembly

3.4 Typical connection schemes

The following information provides some typical connection schemes for single card, two-card and two-mainframe system configurations. Connection schemes for the multi-pin connector card use some of the techniques presented in paragraph 3.3.2. Keep in mind that these are only examples to demonstrate various ways to wire a test system. Connection details for both connector cards (multi-pin and screw terminal connector cards) are provided in paragraph 3.3.

3.4.1 Single card system

Figure 3-12 shows how external connections can be made to a single card system that uses the multi-pin connector card. This single card system is configured as two 1 × 20 multiplexers. To accomplish this, the appropriate bank-to-bank jumpers must be installed to connect Banks A and B together and Banks C and D together.

Instrumentation and DUTs are hard-wired to the Model 7011-MTR male bulkhead connector. This connector has solder cups that will accept wire size up to #24 AWG. The test system is connected to the multiplexer using the Model 7011-MTC-2 round cable assembly. This cable mates directly to both the external bulkhead connector and the Model 7011-C multiplexer card assembly. Notice that the bulkhead connector is shown mounted to a fixture to help keep the cabling stable during the test.

The single card system in Figure 3-13 is identical to the system in the previous illustration, except for the connection scheme. The system in Figure 3-13 uses the screw terminal connector card. With this card, single conductor connections are made directly from the terminal blocks of the connector card to instrumentation and DUTs.

When using a single card system, you will want to make sure that the card remains electrically isolated from any other switching cards. There are several ways to ensure isolation for a single card in the Model 7001 mainframe:

1. Vacate the other mainframe slot. If there is a Model 701X card installed in the other slot, remove it.
2. Remove the backplane jumpers on the multiplexer card. This will disconnect the card from the analog backplane of the mainframe.
3. Remove the backplane jumpers from the switching card installed in the other slot.

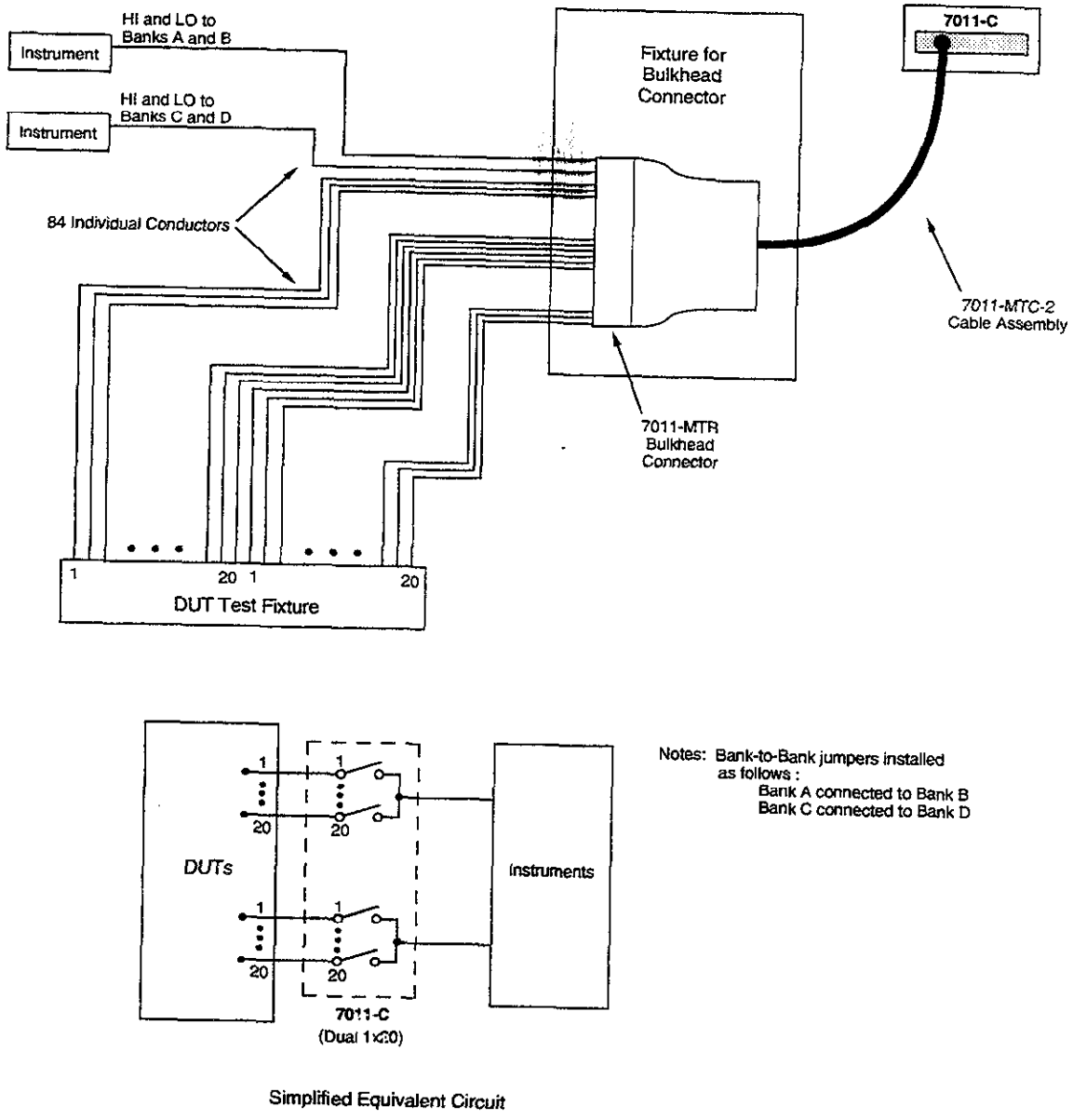
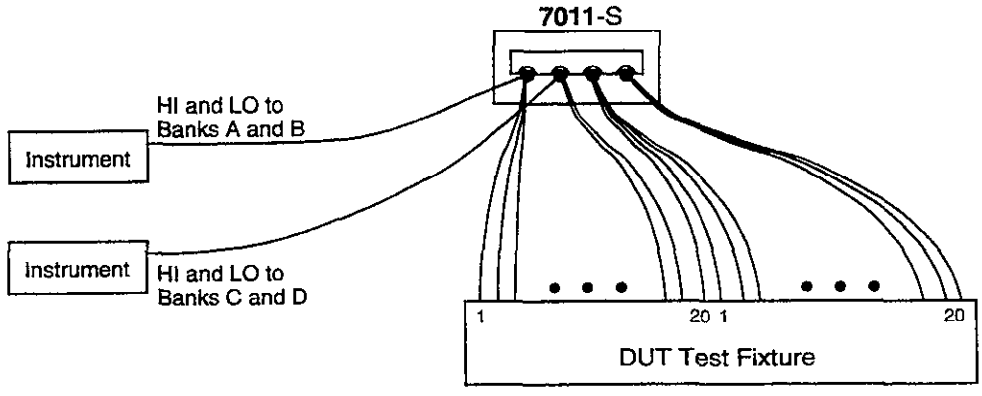
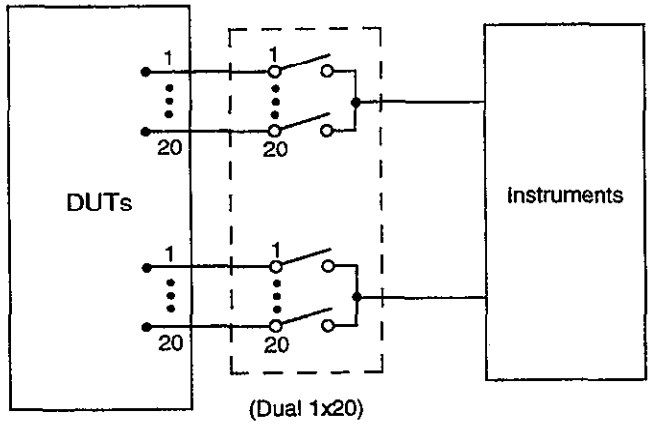


Figure 3-12
Single card system example (multi-pin connector card)





Notes: Bank-to-bank jumpers installed as follows :
Bank A connected to Bank B
Bank C connected to Bank D

Simplified Equivalent Circuit

Figure 3-13
Single card system example (screw terminal connector card)

3.4.2 Two-card system

Both Figure 3-14 and Figure 3-15 show a system using two multiplexer cards installed in one Model 7001 mainframe to configure a single 1 × 80 multiplexer system. Each card is configured as a single 1 × 40 multiplexer. To accomplish this, all bank-to-bank jumpers (both cards) are installed to connect Banks A, B, C, and D together. By leaving the backplane jumpers of both cards installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001 mainframe resulting in the 1 × 80 configuration.

Figure 3-14 shows how external connections can be made for the multi-pin connector cards. In this example, a single Model 7011-MTC-2 round cable assembly is cut in half to provide two cables, each of which is unterminated at one end. The unterminated ends of the two cables are hard-wired to the instrument and DUT as shown in the drawing. The other ends of these cables mate directly to the Model 7011-C multiplexer card assemblies.

Figure 3-15 shows how external connections can be made for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.

3.4.3 Two-mainframe system

Both Figure 3-16 and Figure 3-17 show a system using three multiplexer cards installed in two Model 7001 mainframes to configure a single 1 × 120 multiplexer system. Each card is configured as a single 1 × 40 multiplexer. To accomplish this, bank-to-bank jumpers of all three cards must be installed to connect Banks A, B, C, and D together.

By leaving the backplane jumpers of the cards in mainframe #1 installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001 mainframe resulting in a 1 × 80 configuration. External bank connections from the instrument to the card in the second mainframe connect the banks of all three cards together to form the 1 × 120 multiplexer system. This system is similar to the Two-card System (see previous paragraph) except that a third multiplexer card (installed in a second mainframe) is added.

Figure 3-16 shows the connection scheme for the multi-pin connector cards. External circuit connections to the Model 7001 #1 mainframe are identical to the ones used for the Two-card System. The third multiplexer card (installed in Model 7001 #2 mainframe) shows how a custom-built cable can be used to make connections to external circuitry. A suitable round cable can be constructed using a 96-pin female DIN connector (Model 7011-KIT-R) with two lengths of Hitachi cable P/N N2807-P/D-50TAB. This cable contains 50 conductors; two lengths provide 100 conductors. This cable will mate to the Model 7011-C multiplexer card assembly. The unterminated end of the cable is connected directly to the instrument and DUT. Notice that the bank connections for the third multiplexer card are made at the instruments.

Figure 3-17 shows connections for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.

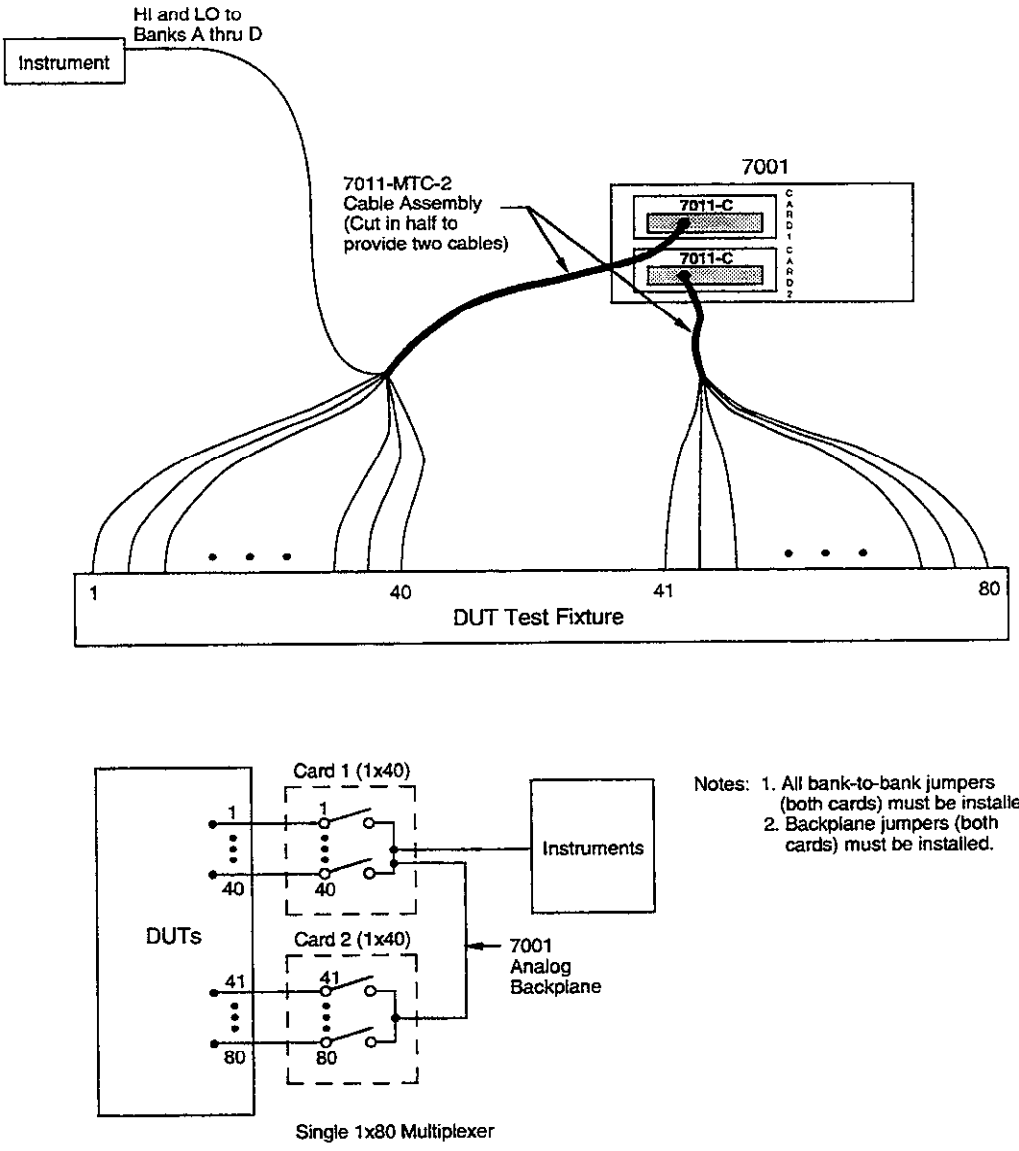
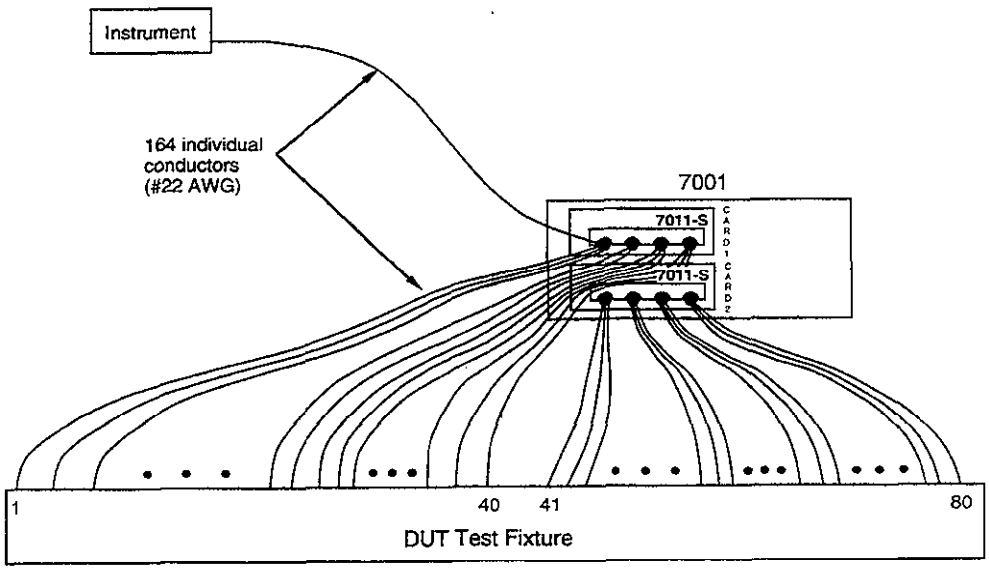
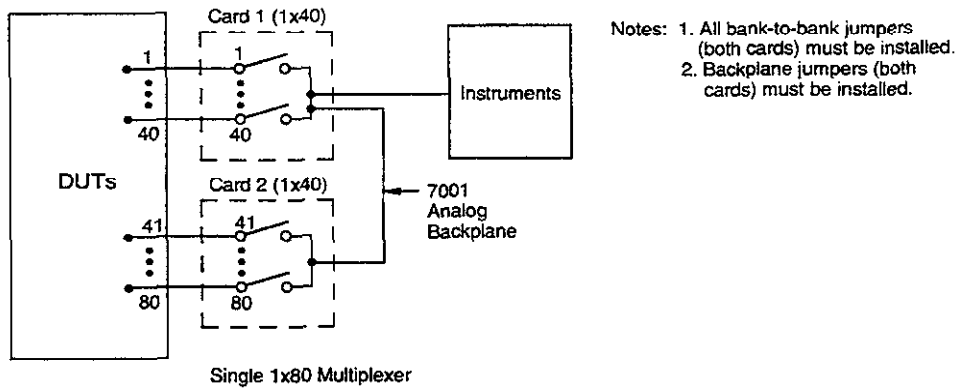


Figure 3-14
Two-card system example (multi-pin connector card)





Simplified Equivalent Circuit

Figure 3-15
Two-card system example (screw terminal connector card)

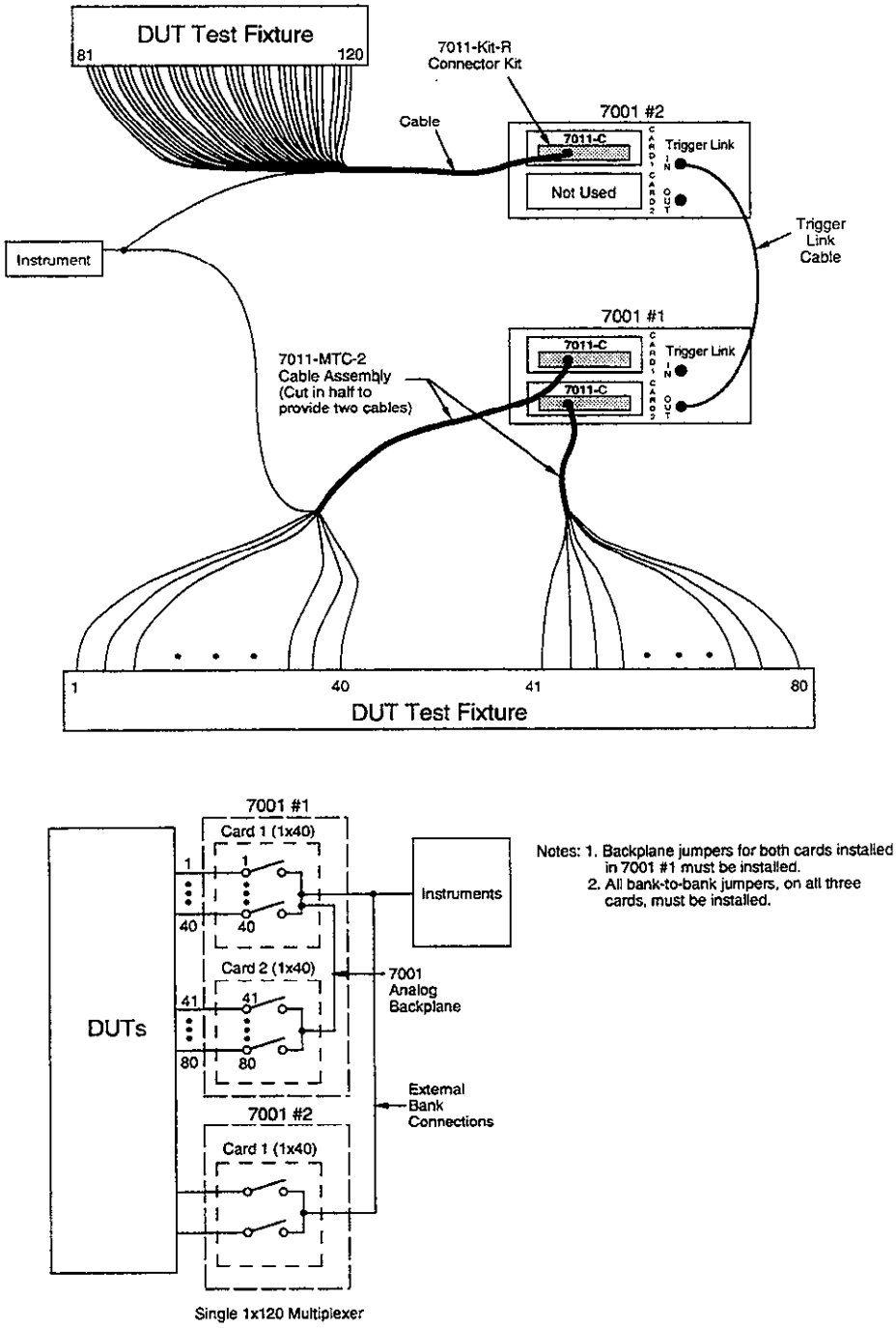
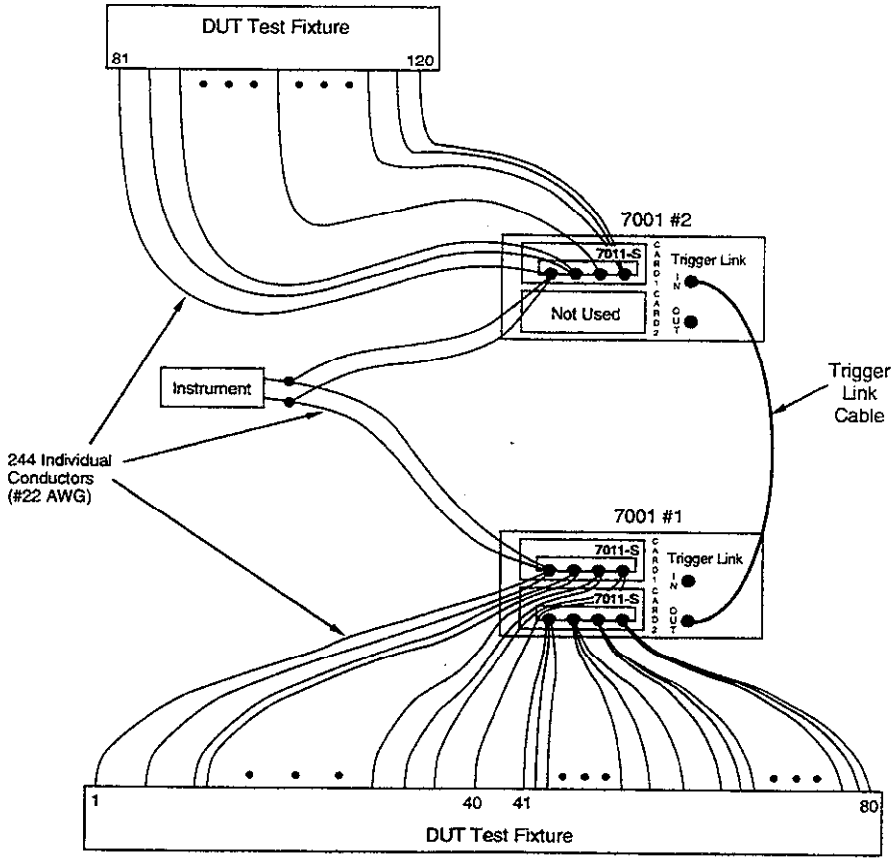
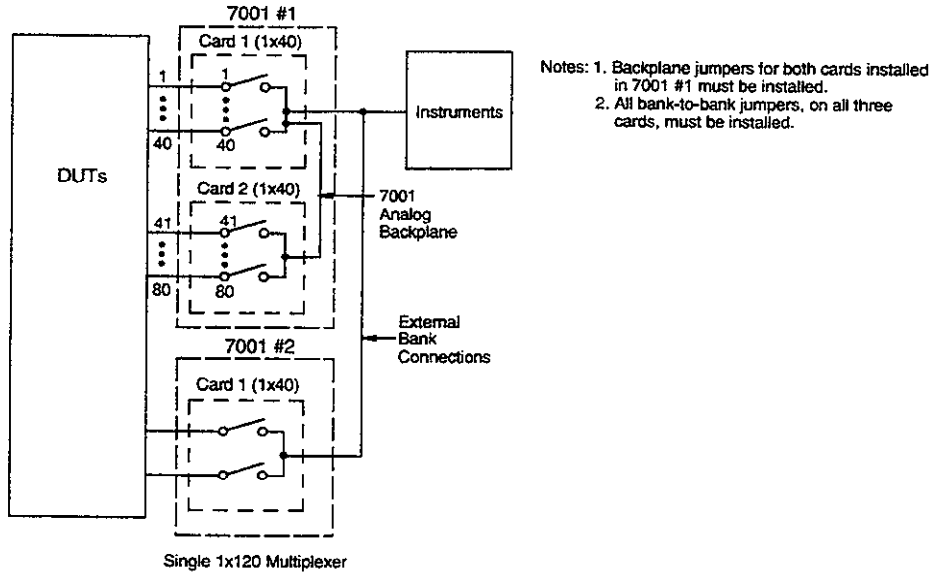


Figure 3-16
Two-mainframe system example (multi-pin connector card)





Simplified Equivalent Circuit

Figure 3-17
Two-mainframe system example (screw terminal connector card)

3.5 Model 7011 installation and removal

This paragraph explains how to install and remove the Model 7011 multiplexer card assembly from the Model 7001 mainframe.

WARNING

Installation or removal of the Model 7011 is to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

NOTE

If using the screw terminal connector card, make sure your external circuitry is wired to the card (as explained in paragraph 3.3.1) before installing the card assembly in the Model 7001 mainframe.

CAUTION

To prevent contamination to the multiplexer card that could degrade performance, only handle the card assembly by the edges and shields.

Multiplexer card installation

Perform the following steps to install the multiplexer card assembly in the Model 7001 mainframe:

WARNING

Turn off power from all instrumentation (including the Model 7001 mainframe) and disconnect their line cords. Make sure all power is removed and any stored energy in external circuitry is discharged.

1. Mate the connector card to the relay card if they are separated. Install the supplied 4-40 screw at the end of the card to secure the assembly. Make sure to handle the cards by the edges and shields to prevent contamination.
2. Facing the rear panel of the Model 7001, select the slot (CARD 1 or CARD 2) that you wish to install the card in.
3. Referring to Figure 3-18 for Model 7011-C installation, or Figure 3-19 for Model 7011-S installation, feed the multiplexer card assembly into the desired slot such that the edges of the relay card ride in the rails.
4. With the ejector arms in the unlocked position, push the card assembly all the way into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the card into the mainframe.
5. For the 7011-C, also install the screw shown in Figure 3-18.

Multiplexer card removal

To remove the multiplexer card assembly, first unlock it by pulling the latches outward, then pull the card assembly out of the mainframe. Remember to handle the card assembly by the edges and shields to avoid contamination that could degrade performance.

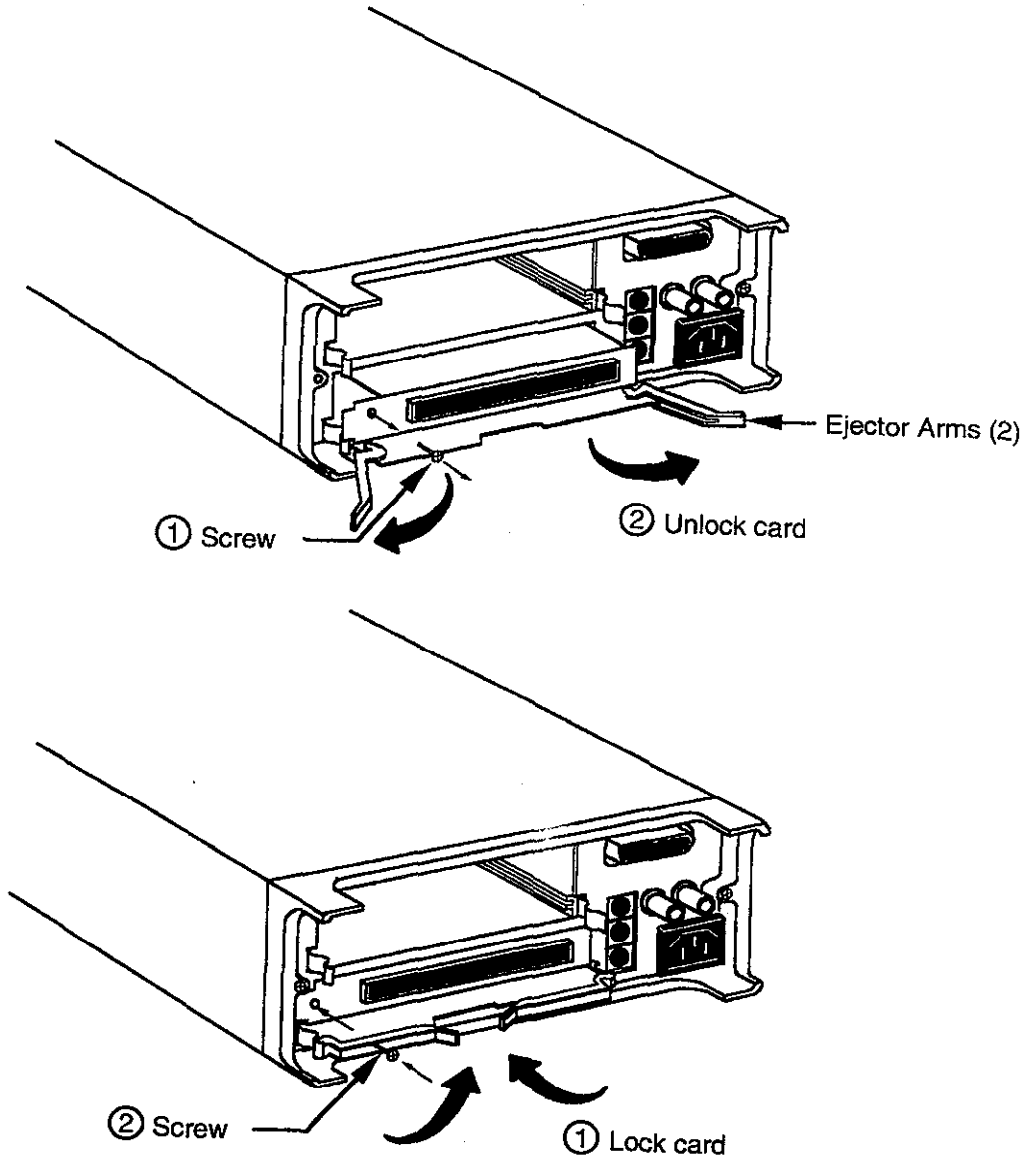


Figure 3-18
Model 7011-C card installation in Model 7001

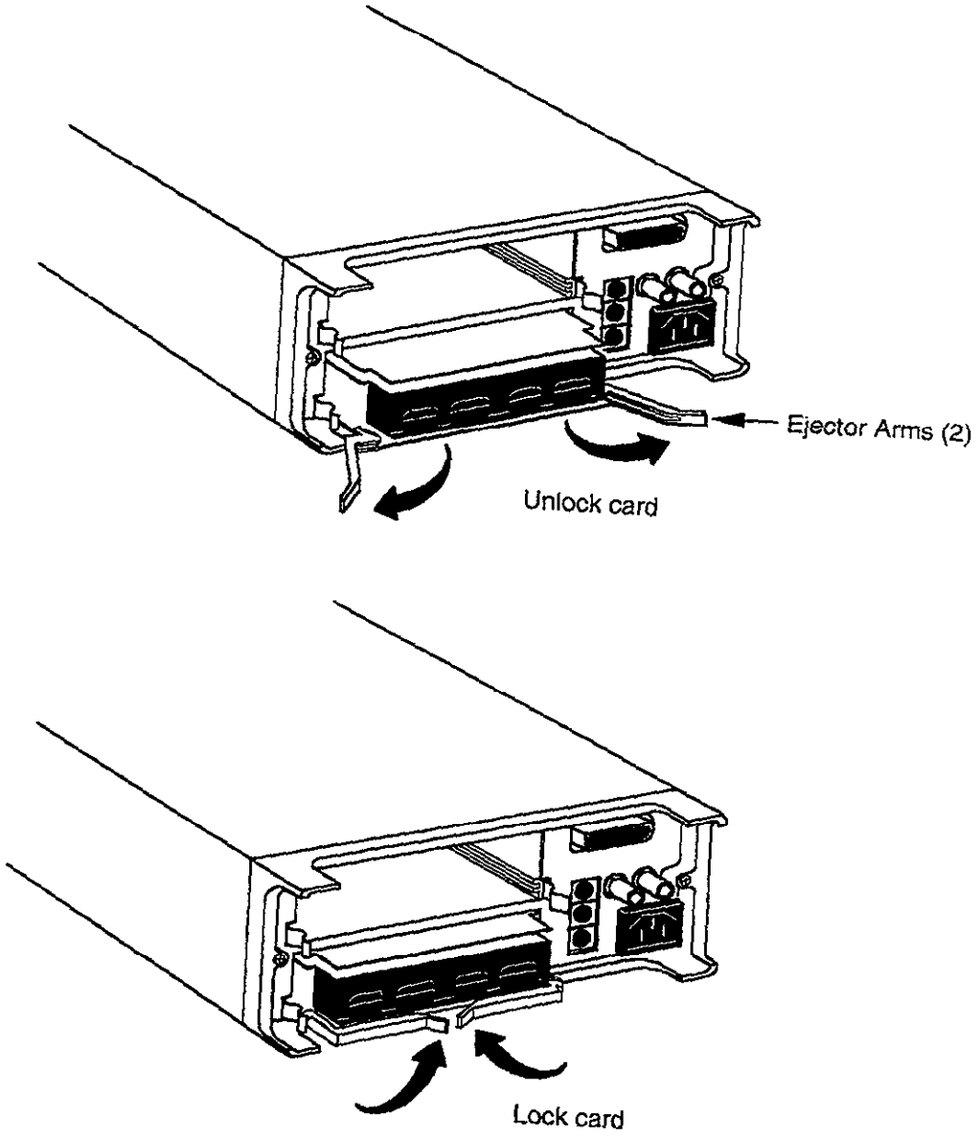


Figure 3-19
7011-S card installation in Model 7001

4

Operation

4.1 Introduction

The information in this section is formatted as follows:

4.2 **Power limits:** Summarizes the maximum power limits of the Model 7011 multiplexer card assembly.

4.3 **Mainframe control of multiplexer card:** Summarizes programming steps to control the multiplexer card from the Model 7001 Switch System mainframe.

4.4 **Multiplexer switching examples:** Provides some typical applications for using the Model 7011.

4.5 **Measurement considerations:** Reviews a number of considerations when using the Model 7011 to make measurements.

4.2 Power limits

CAUTION

To prevent damage to the card, do not exceed the maximum signal level specifications of the card.

Maximum signal levels

To prevent overheating or damage to the relays, never exceed the following maximum signal levels:

DC signals: 110V between any two pins (terminals), 1A switched, 30VA (resistive load).

AC signals: 125V rms or 175V AC peak between any two pins (terminals), 1A switched, 60VA (resistive load)

4.3 Mainframe control of multiplexer card

The following information pertains to the Model 7011 multiplexer card. It assumes that you are familiar with the operation of the Model 7001 mainframe.

If you are not familiar with the operation of the mainframe, it is recommended that you proceed to Getting Started (Section 3) of the Model 7001 Instruction Manual after reading the following information.

4.3.1 Channel assignments

The Model 7001 has a channel status display (Figure 4-1) that provides the real-time state of each available channel. The left portion of the display is for slot 1 (Card 1), and the right portion is for slot 2 (Card 2).

Multiplexer organization of the channel status display for each slot is shown in Figure 4-2. The card contains 40 channels and is made up of four banks (Bank A, B, C, and D) of 10 multiplexer inputs as shown in the illustration.

To control the multiplexer (mux) card from the mainframe, each multiplexer input must have a unique CHANNEL assignment which includes the slot number that the card is installed in. The CHANNEL assignments for the multiplexer card are provided in Figure 4-3. Each CHANNEL assignment is made up of the slot designator (1 or 2) and the multiplexer channel. To be consistent with Model 7001 operation, the slot designator and mux input are separated by exclamation points (!). Some examples of CHANNEL assignments are as follows:

CHANNEL 1!1 = Slot 1, Channel 1 (Input 1 of Bank A)

CHANNEL 1!40 = Slot 1, Channel 40 (Input 10 of Bank D)

CHANNEL 2!23 = Slot 2, Channel 23 (Input 3 of Bank C)

CHANNEL 2!36 = Slot 2, Input 36 (Input 6 of Bank D)

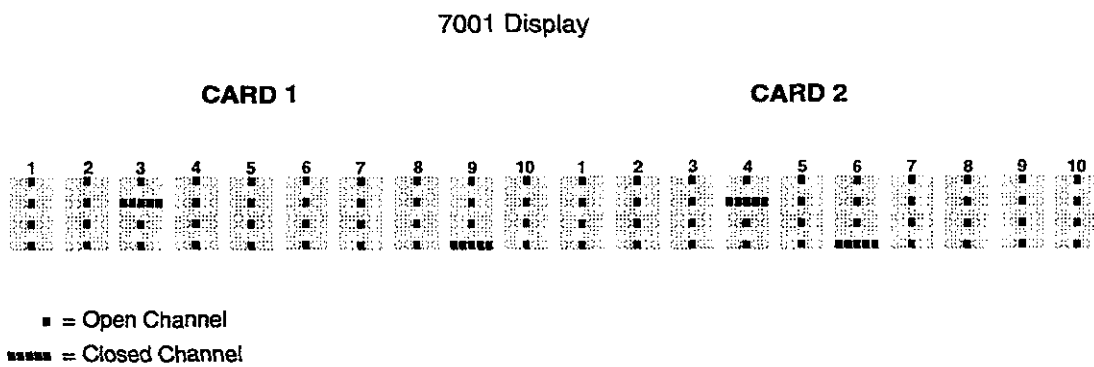


Figure 4-1
Channel status display

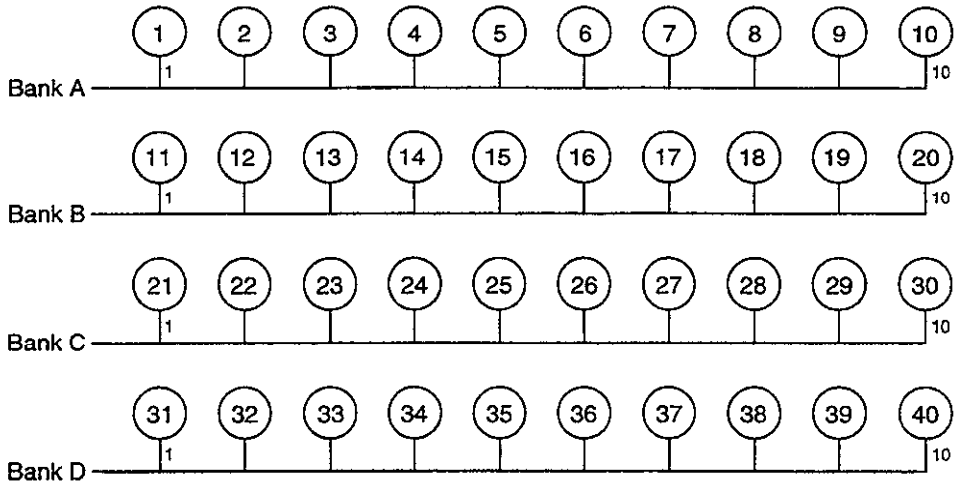
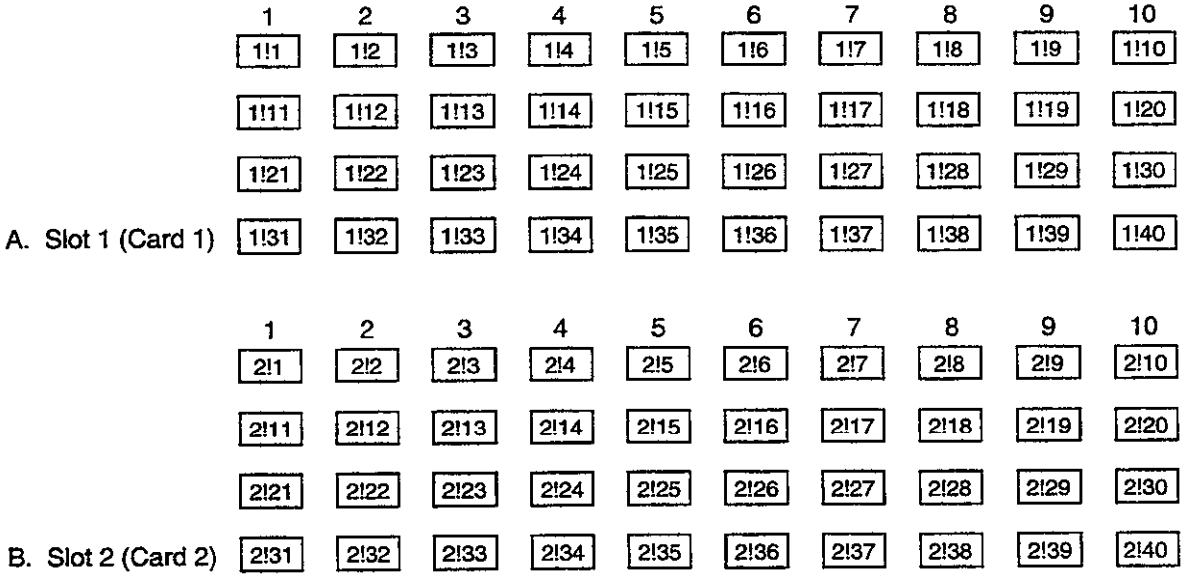


Figure 4-2
Display organization for multiplexer channels



Examples : 1!18 = Slot 1, Channel 18 (Input 8, Bank B)
2!36 = Slot 2, Channel 36 (Input 6, Bank D)

Figure 4-3
Model 7011 programming channel assignments

4.3.2 Front panel control

Closing and opening channels

A multiplexer channel is closed from the front panel by simply keying in the CHANNEL assignment and pressing CLOSE. For example, to close channel 36 (Input 6 of Bank D) of a multiplexer card installed in slot 2, key in the following channel list and press CLOSE:

SELECT CHANNELS 2!36

The above closed channel can be opened by pressing OPEN or OPEN ALL. The OPEN key opens only the channels specified in the channel list, and OPEN ALL opens all channels.

The following display is an example of a channel list that consists of several channels:

SELECT CHANNELS 2!1, 2!3, 2!22-2!25

Notice that channel entries are separated by commas (,). A comma is inserted by pressing ENTER or the right cursor key ▷). The channel range is specified by using the hyphen (-) key to separate the range limits. Pressing CLOSE will close all the channels specified in the channel list. Pressing OPEN (or OPEN ALL) will open the channels.

Scanning channels

Multiplexer channels are scanned by creating a scan list and configuring the Model 7001 to perform a scan. The scan list is created in the same manner as a channel list (see Closing and Opening Channels). However, the scan list is specified from the "SCAN CHANNEL" display mode.)The SCAN LIST key toggles between the channel list and the scan list.) The following shows an example of a scan list:

SCAN CHANNELS 2!1, 2!3, 2!21-2!25

When a scan is performed, the channels specified in the scan list will be scanned in the order that they are presented in the scan list.

A manual scan can be performed by using the RESET default conditions of the Model 7001. RESET is selected from the SAVESETUP menu of the main MENU. When RESET is performed, the mainframe is configured for an infinite number of manual scans. The first press of STEP takes the mainframe out of the idle state. The next press of STEP will close the first channel specified in the scan list. Each subsequent press of STEP will select the next channel in the scan list.

4.3.3 IEEE-488 bus operation

Bus operation is demonstrated using HP BASIC 4.0. The programming statements assume that the primary address of the mainframe is 07.

Closing and opening channels

The following SCPI commands are used to close and open channels:

:CLOSe <list>
:OPEN <list>|ALL

The following statement closes channels 1!1, and 1!3 through 1!11:

OUTPUT 707; ":clos (@ 1!1, 1!3:1!11)"

Notice that the colon (:) is used to separate the range limits.

Either of the following statements will open channels 1!1 and 1!3 through 1!11:

OUTPUT 707; ":open (@ 1!1, 1!3:1!11)"
OUTPUT 707; ":open all"

Scanning channels

There are many commands associated with scanning. However, it is possible to configure a scan using as little as four commands. These commands are listed as follows:

```
*RST
:TRIGger:SEQuence:COUNt:AUTo ON"
:ROUTe:SCAN <list>
:INIT
```

The first command resets the mainframe to a default scan configuration. The second command automatically sets the channel count to the number of channels in the Scan List, the third command defines the Scan List and the fourth command takes the Model 7001 out of the idle state.

The following program will perform a single scan through all 40 channels of a multiplexer card installed in slot 1:

```
10 OUTPUT 707; "*RST"
20 OUTPUT 707; ":trig:seq:coun:auto on"
30 OUTPUT 707; ":scan (@ 1!1:1!40)"
40 OUTPUT 707; ":init"
50 END
```

Line 10 Selects a default configuration for the scan.
Line 20 Sets channel count to the scan-list-length.
Line 30 Defines the scan list.
Line 40 Take the Model 7001 out of the idle state. The scan is configured to start as soon as this command is executed.

When the above program is run, the scan will be completed in approximately 240 milliseconds (3msec delay for each relay close and a 3msec delay for each open), which is too fast to view from the front panel. An additional relay delay can be added to the program to slow down the scan for viewing. The program is modified by adding line 25 to slow down the scan. Also, Line 5 is added to the beginning of the program to ensure that all channels are open before the scan is started.

```
5  OUTPUT 707; ":open all"
10 OUTPUT 707; "*RST"
20 OUTPUT 707; ":trig:seq:coun:auto on"
25 OUTPUT 707; ":trig:del 0.25"
30 OUTPUT 707; ":scan (@ 1!1:1!40)"
40 OUTPUT 707; ":INIT"
50 END
```

Line 5 Opens all channels.
Line 25 Sets a 1/4 second delay after each channel closes.

4.4 Multiplexer switching examples

This paragraph presents some typical applications for the Model 7011. These include resistor testing, transistor testing, and resistivity testing, which shows how to use the Model 7011 with a matrix card (Model 7012).

4.4.1 Resistor testing

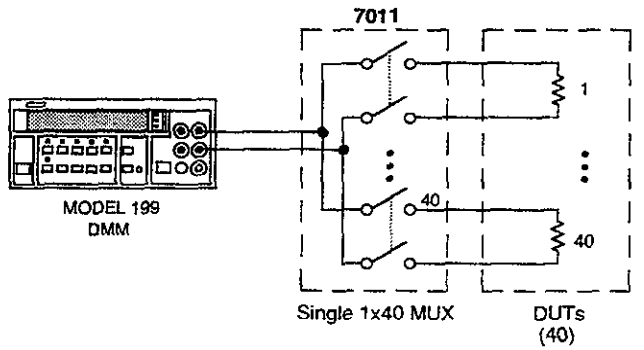
The Model 7011 can be used to test a large number of resistors using only one test instrument or group of instruments. Such tests include two-wire and four-wire resistance measurements using a DMM, and low-resistance measurements using a current source and sensitive digital voltmeter, as discussed in the following paragraphs.

Two-wire resistance tests

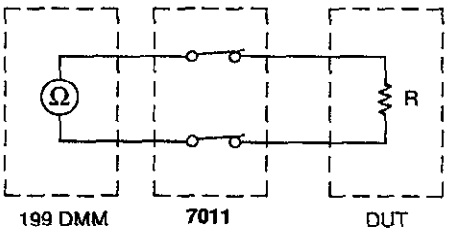
Figure 4-4 shows a typical test setup for making two-wire resistance measurements. The Model 7011 card provides the switching function, while the resistance measurements are made by a Model 199 DMM. Since only two-pole switching is required for this application, one Model 7011 card can be used to switch up to 40 resistors (additional multiplexer banks can be added, if desired, by adding more cards).

Accuracy of measurements can be optimized by minimizing stray resistance.

Make connecting wires as short as possible to minimize path resistance. Another technique is to short one of the multiplexer inputs, close the shorted channel and then enable the DMM zero feature to cancel path resistance. Leave zero enabled for the entire test.



A. Test Configuration



B. Simplified Equivalent Circuit

Figure 4-4
2-wire resistance testing

Four-wire resista[illegible] tests

More precise measurements over a wider range of system and DUT conditions can be obtained by using the four-wire measurement scheme shown in Figure 4-5. Here, separate sense leads from the Model 196 DMM are routed through the multiplexer to the resistor under test. The extra set of sense leads minimizes the effects of voltage drops across the test leads. Note, however, that an extra two poles of switching are required for each resistor tested. For this reason, only 20 resistors per card can be tested using this configuration.

The Model 7011 can be configured for 20 channels of 4-pole operation by isolating Banks A and B from Banks C and D, and by programming the Model 7001 mainframe for 4-pole mode. The resulting paired channels are shown in Table 4-1.

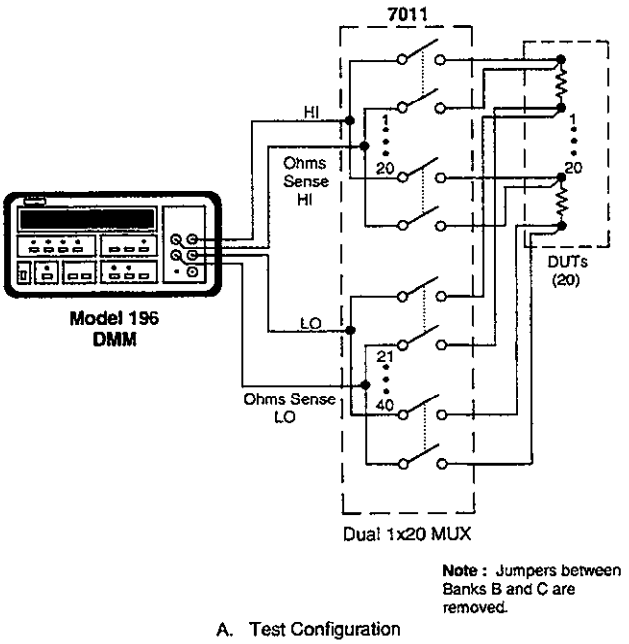
Table 4-1
Paired Channels in 4-pole Operation

7001 CHANNEL assignment	Channel pair in 4-pole	Connection designations
1	1 and 21	Bank A, In 1 and Bank C, In 1
2	2 and 22	Bank A, In 2 and Bank C, In 2
3	3 and 23	Bank A, In 3 and Bank C, In 3
4	4 and 24	Bank A, In 4 and Bank C, In 4
5	5 and 25	Bank A, In 5 and Bank C, In 5
6	6 and 26	Bank A, In 6 and Bank C, In 6
7	7 and 27	Bank A, In 7 and Bank C, In 7
8	8 and 28	Bank A, In 8 and Bank C, In 8
9	9 and 29	Bank A, In 9 and Bank C, In 9
10	10 and 30	Bank A, In 10 and Bank C, In 10
11	11 and 31	Bank B, In 1 and Bank D, In 1
12	12 and 32	Bank B, In 2 and Bank D, In 2
13	13 and 33	Bank B, In 3 and Bank D, In 3
14	14 and 34	Bank B, In 4 and Bank D, In 4
15	15 and 35	Bank B, In 5 and Bank D, In 5
16	16 and 36	Bank B, In 6 and Bank D, In 6
17	17 and 37	Bank B, In 7 and Bank D, In 7
18	18 and 38	Bank B, In 8 and Bank D, In 8
19	19 and 39	Bank B, In 9 and Bank D, In 9
20	20 and 40	Bank B, In 10 and Bank D, In 10

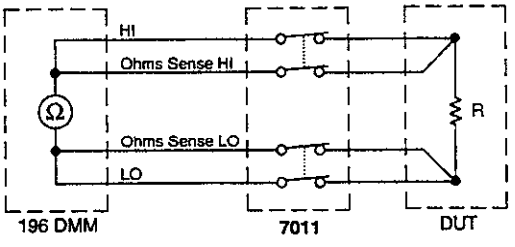
Bank jumper removal is described in paragraph 3.3.1. To configure the connector card for 4-pole operation, only remove the jumpers between Banks C and D (W102 and W103).

Selecting 4-pole operation for a Model 7001 card slot is discussed in Section 4 of the Model 7001 Instruction Manual. After the 4-pole mode is selected, the Model 7001 mainframe will display just 20 channels for the chosen card slot. Each closed channel will also close its paired channel on the card.

Although the four-wire connection scheme minimizes problems caused by voltage drops, there is one other potentially troublesome area associated with low resistance measurements: thermal EMFs caused by the relay contacts. In order to compensate for thermal EMFs, the offset-compensated ohms feature of the Model 196 DMM should be used. To use this feature, short the HI and LO terminals of one of the bank inputs, then close the relay. Enable zero on the Model 196, then select offset-compensated ohms.



A. Test Configuration



B. Simplified Equivalent Circuit

Figure 4-5
Four-wire resistance testing

Low-level resistance measurements

Many times, it is necessary to make resistance measurements with either lower voltage sensitivity or higher currents than are available with ordinary DMMs. Examples of cases where low-level resistance measurements may be necessary include the testing of PC board traces, contacts, bus bars, and low resistance shunts.

Figure 4-6 shows a typical test configuration for a switching system capable of testing a number of low resistance devices. The Model 220 Current Source forces current through the device under test, while the Model 182 Sensitive Digital Voltmeter measures the resulting voltage across the device.

Since low voltage levels are being measured, thermal EMF offsets generated by relay and connector contacts will have a detrimental effect on measurement accuracy unless steps are taken to avoid them (the Model 7011 has been designed to keep relay EMF at a minimal level.). Thermal EMF effects can be virtually eliminated by taking two voltage measurements, E_1 and E_2, the first with the current, I, flowing in one direction, and the second with a current, I, of the same magnitude flowing in the opposite direction. The resistance can then be calculated as follows:

$$R = \frac{E_2 - E_1}{2I}$$

Note that simply reversing the current source polarity will result in a 2X accuracy specification change. To avoid this problem, matrix switching could be added to the test system to reverse the current. See paragraph 4.4.3.

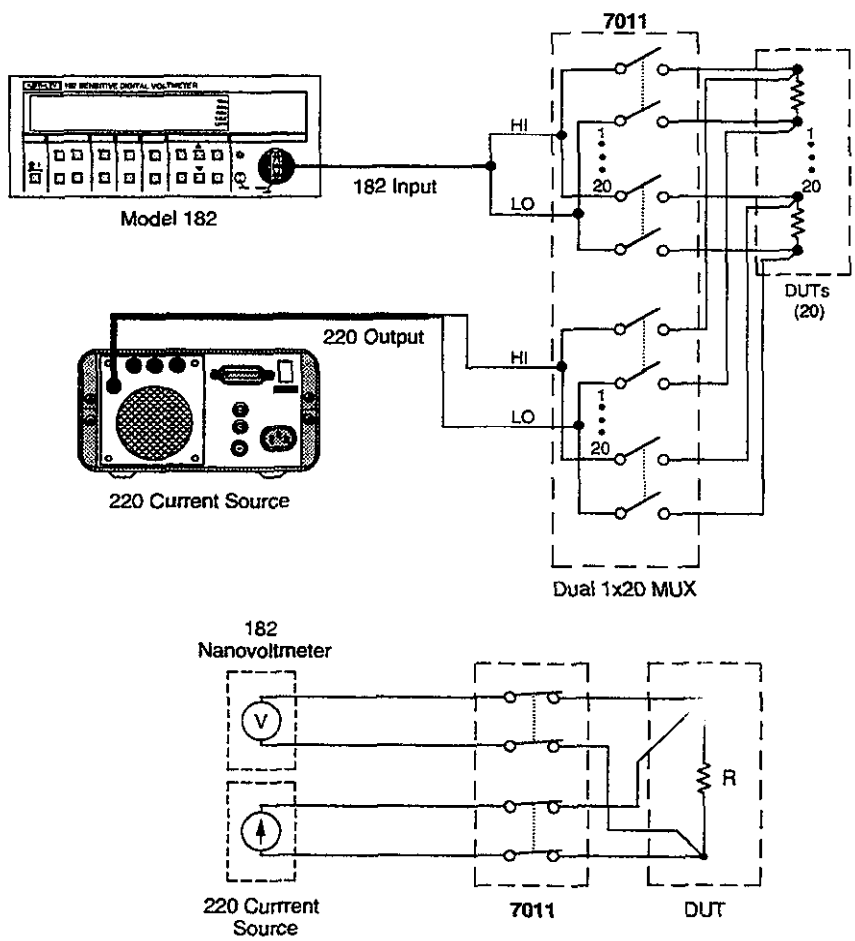


Figure 4-6
Low resistance testing

4.4.2 Transistor testing

Typical transistor tests that can be performed with the aid of the Model 7011 include current gain tests, leakage tests, as well as tests to determine the common-emitter characteristics of the device. The following paragraphs discuss these tests and give typical equipment configurations for the tests.

Current gain tests

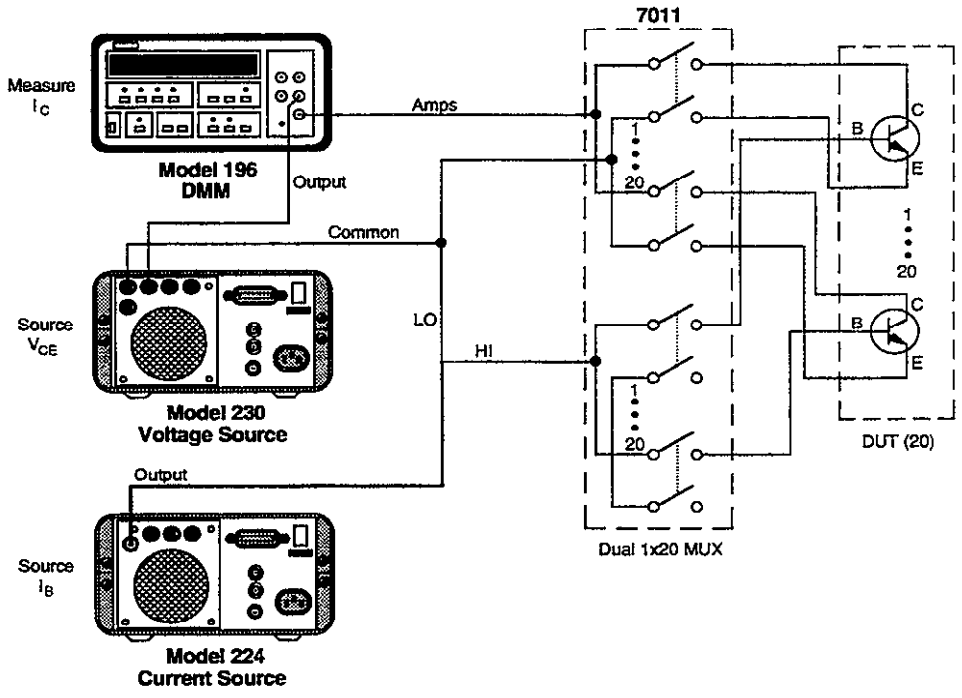
The DC or static common-emitter current gain of a transistor can be determined by biasing the transistor for a specific value of base current, I_B, and then measuring the collector current, I_C. The DC common-emitter current gain, β, of the transistor is then determined as follows:

$$\beta = \frac{I_C}{I_B}$$

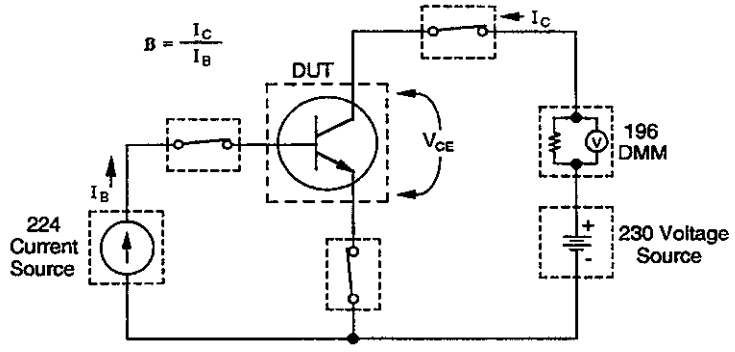
Figure 4-7 shows the test configuration and equivalent circuit for the current gain test. The Model 224 Current Source is used to source the base current, I_B. The Model 230 Voltage Source supplies the collector-emitter voltage, V_{CE}, and the collector current, I_C, is measured by the Model 196 DMM. Switching among the transistors being tested is, of course, performed by the Model 7011 multiplexer card.

In order to perform the current gain test, the voltage source is first set to the desired value of V_{CE}. The current source is then set to a base current value that will result in the desired value of I_C as measured by the DMM. The current gain can then be calculated as outlined above.

In order to reduce errors caused by voltage burden, use a higher current range on the Model 196 DMM. Doing so will result in the loss of one or two decades of resolution, but 3 ½ or 4 ½-digit resolution will probably be adequate for most situations.



A. Test Configuration



B. Simplified Equivalent Circuit

Figure 4-7
Configuration for current gain and common-emitter test

Common-emitter characteristic tests

Common-emitter characteristics are determined by setting the base current, I_B, to specific values. At each I_B value, the collector-emitter voltage, V_{CE}, is swept across the desired range at specific intervals, and the collector current, I_C, is then measured. When the data are plotted, the result is the familiar family of common-emitter curves (Figure 4-8).

The same test configuration that is used for current gain tests can be used for measuring common-emitter characteristics. The Model 224 is used to set the base current, I_B, to the desired values. The Model 230 Voltage Source provides the collector-emitter voltage, V_{CE}, and the Model 196 DMM measures the collector current, I_C.

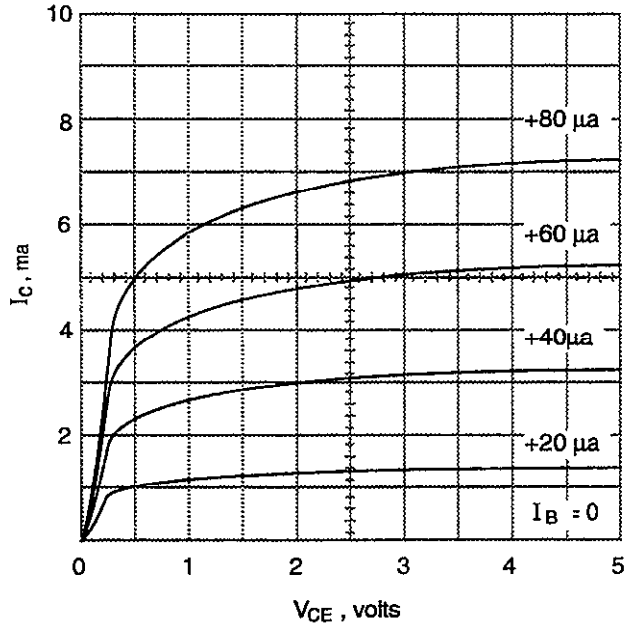


Figure 4-8
Typical common-emitter characteristics

4.4.3 Testing with matrix cards

The Model 7011 can be added to a matrix switching system to enhance the test capabilities of that system. The following paragraphs discuss an overall multiplexer/matrix switching system and also briefly outline a typical test that can be made with such a system.

Multiplexer and matrix card connections

Figure 4-9 shows a typical system using Model 7012 and 7011 cards together. In this instance, the multiplexer card is configured as four 1 × 10 multiplexers. Note that rows of the matrix card are connected to the banks of the multiplexer card through the analog backplane of the mainframe; no external wiring is necessary to connect the two cards together.

In this application, the DUTs are connected to the bank inputs on the multiplexer card, allowing a large number of DUTs to be switched through the matrix card. Also, the instruments are connected to the columns on the matrix card. This particular configuration is best suited for applications requiring a large number of DUTs to be connected to several instruments. In other cases, the test configuration may call for a large number of instruments and few DUTs. In those situations, the instruments would be connected to the multiplexer inputs, and the DUTs would be connected to the columns.

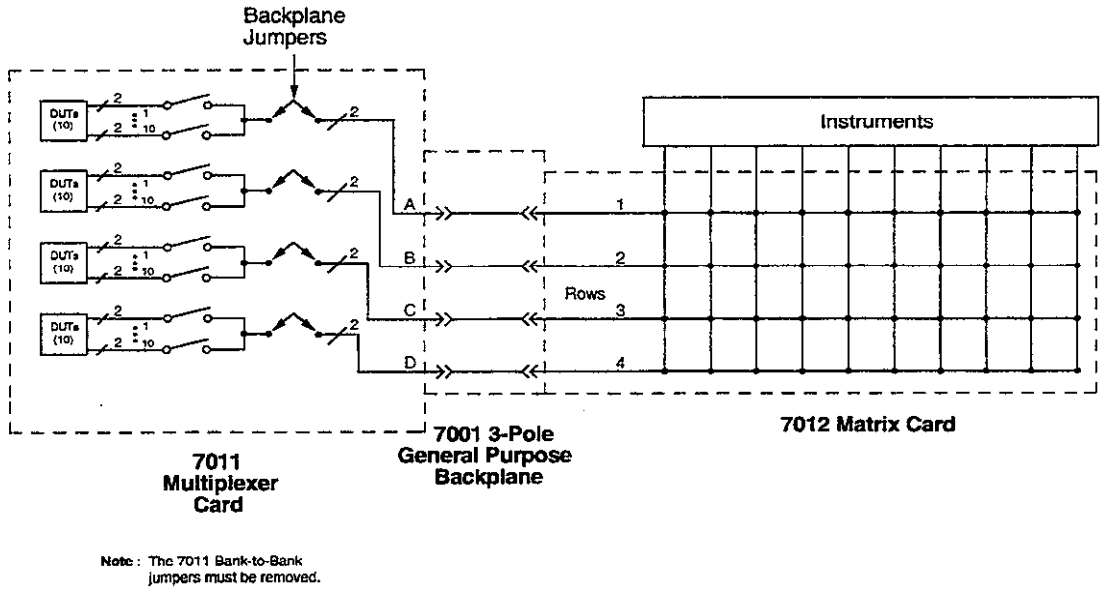


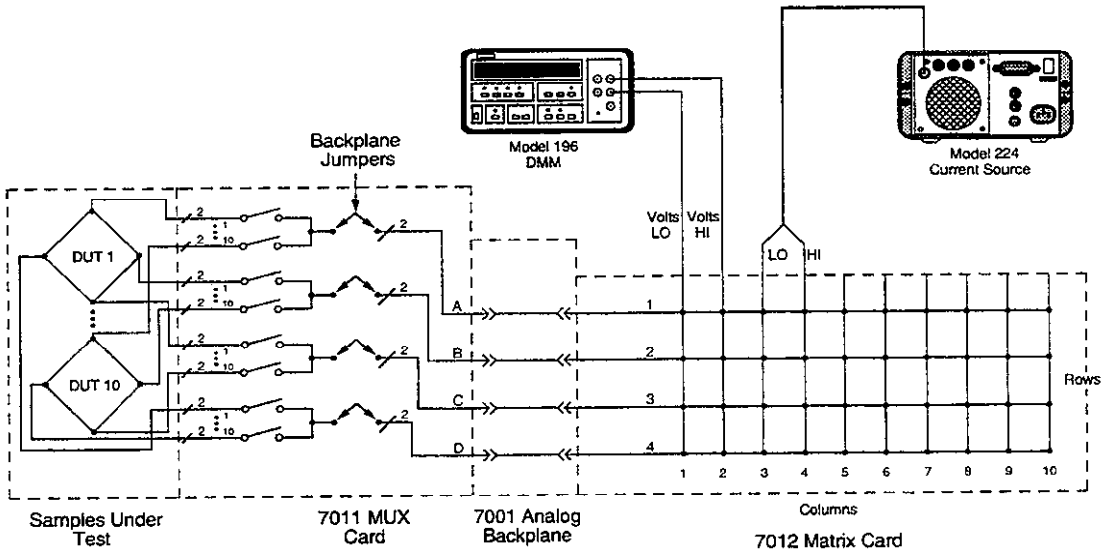
Figure 4-9
Connecting multiplexer and matrix cards together

Resistivity tests

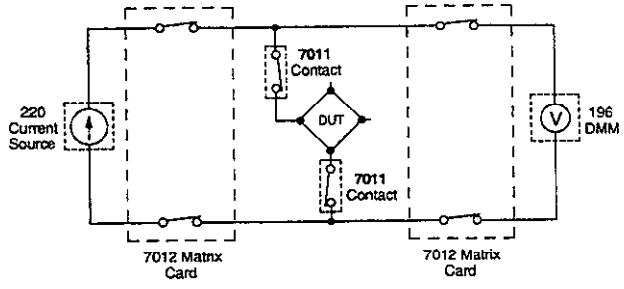
The general test configuration shown in Figure 4-10 can be used to perform resistivity tests on semiconductors. Such tests can yield important information such as doping concentration.

As shown in Figure 4-10, the Model 7011 switches ten samples for the test. The Model 7012 Matrix card allows any device test node to be connected to any instrument terminal. The Model 220 Current Source forces a current through the DUT, and the Model 196 DMM measures the voltage across the device. In order to minimize errors caused by sample loading, the Model 196 should be used on the 300mV or 3V ranges. Also, resistance values should be 1MΩ or less.

In order to perform the tests, a current (from the Model 220) is applied to two terminals, and the voltage is measured (by the Model 196) across the two opposite terminals. A total of eight such measurements are required, as shown in Figure 4-11.



A. Connections



B. Simplified Equivalent Circuit (One measurement leg shown)

Figure 4-10
Resistivity test configuration

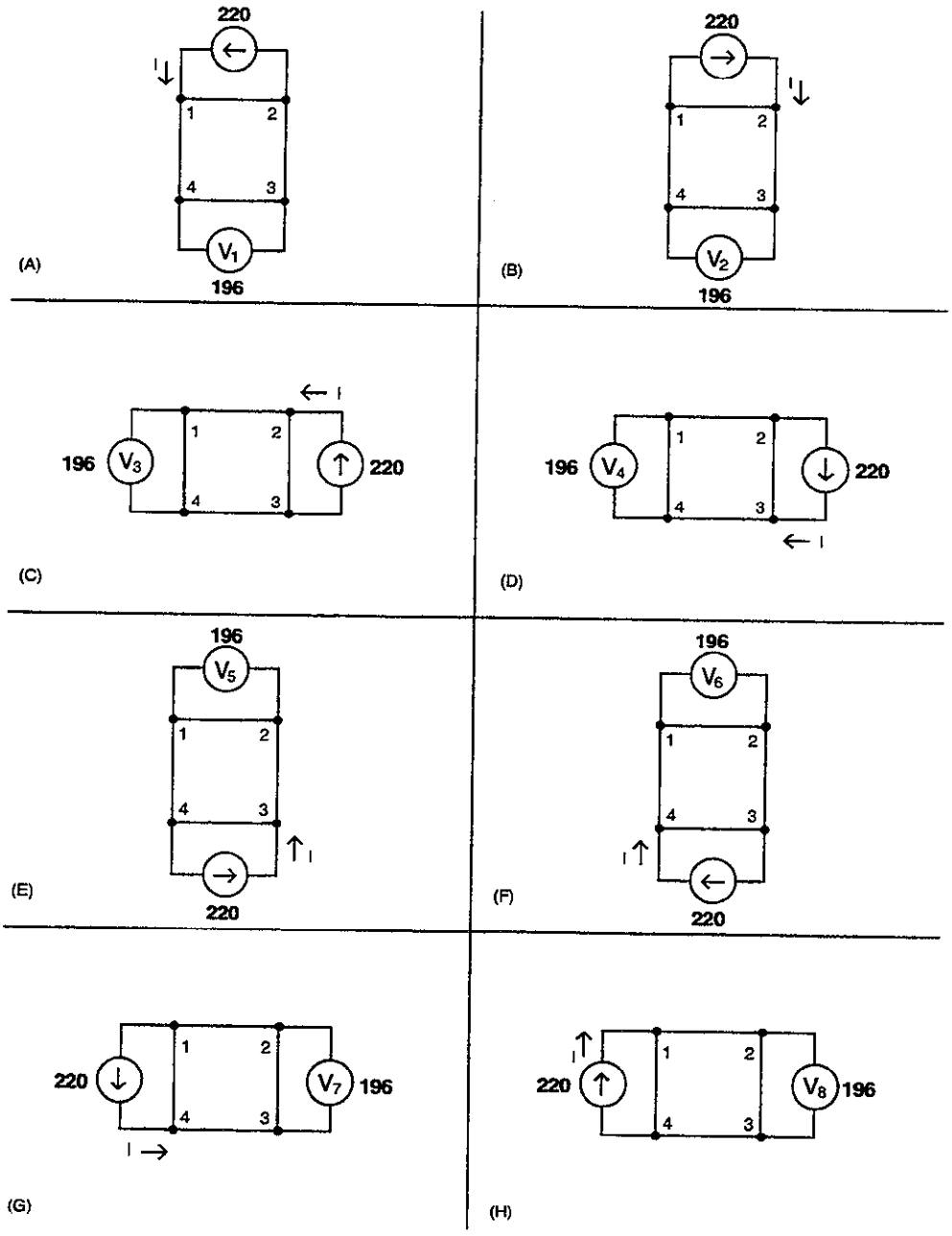


Figure 4-11
Measurement required for resistivity test

Once the measurements have been taken, the resistivity can be calculated. Two values of resistivity, A and B, are initially computed as follows:

$$\sigma_A = \frac{1.1331 f_A t_S (V_2 + V_4 - V_1 - V_3)}{I}$$

$$\sigma_B = \frac{1.1331 f_B t_S (V_6 + V_8 - V_5 - V_7)}{I}$$

Where:

σ_A and σ_B are the resistivities in Ω-cm,

t_S is the sample thickness in cm,

V_1 through V_8 are the voltages measured by the Model 196,

I is the current through the sample in amperes,

f_A and f_B are geometrical factors based on sample symmetry ($f_A = f_B = 1$) for perfect symmetry.

Once σ_A and σ_B are known, the average resistivity, σ_{AVG}, can be determined as follows:

$$\sigma_{AVG} = \frac{\sigma_A - \sigma_B}{2}$$

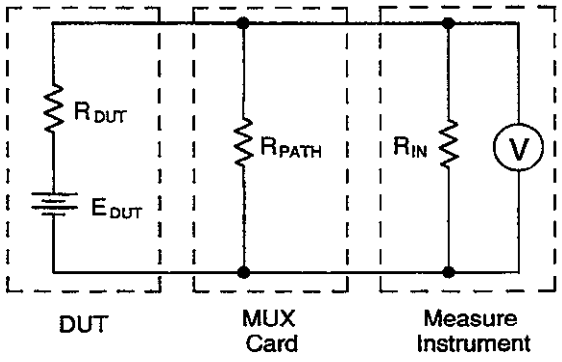
4.5 Measurement considerations

Many measurements made with the Model 7011 are subject to various effects that can seriously affect low-level measurement accuracy. The following paragraphs discuss these effects and ways to minimize them.

4.5.1 Path isolation

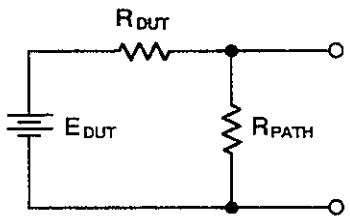
The path isolation is simply the equivalent impedance between any two test paths in a measurement system. Ideally, the path isolation should be infinite, but the actual resistance and distributed capacitance of cables and connectors results in less than infinite path isolation values for these devices.

Path isolation resistance forms a signal path that is in parallel with the equivalent resistance of the DUT, as shown in Figure 4-12. For low-to-medium device resistance values, path isolation resistance is seldom a consideration; however, it can seriously degrade measurement accuracy when testing high-impedance devices. The voltage measured across such a device, for example, can be substantially attenuated by the voltage divider action of the device source resistance and path isolation resistance, as shown in Figure 4-13. Also, leakage currents can be generated through these resistances by voltage sources in the system.



R_{DUT} = Source Resistance of DUT
E_{DUT} = Source EMF of DUT
R_{PATH} = Path Isolation Resistance
R_{IN} = Input Resistance of Measuring Instrument

Figure 4-12
Path isolation resistance



$$E_{OUT} = \frac{E_{DUT}\ R_{PATH}}{R_{DUT} + R_{PATH}}$$

Figure 4-13
Voltage attenuation by path isolation resistance

Any differential isolation capacitance affects DC measurement settling time as well as AC measurement accuracy. Thus, it is often important that such capacitance be kept as low as possible. Although the distributed capacitance of the matrix card is generally fixed by design, there is one area where you do have control over the capacitance in your system; the connecting cables. To minimize capacitance, keep all cables as short as possible

4.5.2 Magnetic fields

When a conductor cuts through magnetic lines of force, a very small current is generated. This phenomenon will frequently cause unwanted signals to occur in the test leads of a switching matrix system. If the conductor has sufficient length, even weak magnetic fields like those of the earth can create sufficient signals to affect low-level measurements.

Two ways to reduce these effects are: (1) reduce the lengths of the test leads, and (2) minimize the exposed circuit area. In extreme cases, magnetic shielding may be required. Special metal with high permeability at low flux densities (such as mu metal) is effective at reducing these effects.

Even when the conductor is stationary, magnetically-induced signals may still be a problem. Fields can be produced by various signals such as the AC power line voltage. Large inductors such as power transformers can generate substantial magnetic fields, so care must be taken to keep the switching and measuring circuits a good distance away from these potential noise sources.

At high current levels, even a single conductor can generate significant fields. These effects can be minimized by using twisted pairs, which will cancel out most of the resulting fields.

4.5.3 Radio frequency interference

RFI (Radio Frequency Interference) is a general term used to describe electromagnetic interference over a wide range of frequencies across the spectrum. Such RFI can be particularly troublesome at low signal levels, but is can also affect measurements at high levels if the problem is of sufficient severity.

RFI can be caused by steady-state sources such as radio or TV signals, or some types of electronic equipment (microprocessors, high speed digital circuits, etc.), or it can result from impulse sources, as in the case of arcing in high-voltage environments. In either case, the effect on the measurement can be considerable if enough of the unwanted signal is present.

RFI can be minimized in several ways. The most obvious method is to keep the equipment and signal leads as far away from the RFI source as possible. Shielding the switching card, signal leads, sources, and measuring instruments will often reduce RFI to an acceptable level. In extreme cases, a specially-constructed screen room may be required to sufficiently attenuate the troublesome signal.

Many instruments incorporate internal filtering that may help to reduce RFI effects in some situations. In some cases, additional external filtering may also be required. Keep in mind, however, that filtering may have detrimental effects on the desired signal.

4.5.4 Ground loops

When two or more instruments are connected together, care must be taken to avoid unwanted signals caused by ground loops. Ground loops usually occur when sensitive instrumentation is connected to other instrumentation with more than one signal return path such as power line ground. As shown in Figure 4-14, the resulting ground loop causes current to flow through the instrument LO signal leads and then back through power line ground. This circulating current develops a small but undesirable voltage between the LO terminals of the two instruments. This voltage will be added to the source voltage, affecting the accuracy of the measurement.

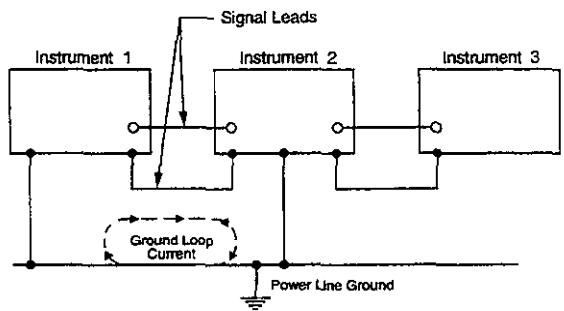


Figure 4-14
Power line ground loops

Figure 4-15 shows how to connect several instruments together to eliminate this type of ground loop problem. Here, only one instrument is connected to power line ground.

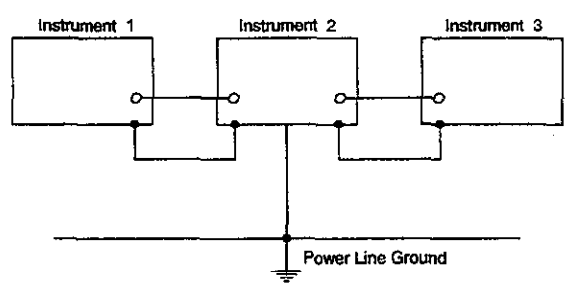


Figure 4-15
Eliminating ground loops

Ground loops are not normally a problem with instruments having isolated LO terminals. However, all instruments in the test setup may not be designed in this manner. When in doubt, consult the manual for all instrumentation in the test setup.

4.5.5 Keeping connectors clean

As is the case with any high-resistance device, the integrity of connectors can be damaged if they are not handled properly. If connector insulation becomes contaminated, the insulation resistance will be substantially reduced, affecting high-impedance measurement paths.

Oils and salts from the skin can contaminate connector insulators, reducing their resistance. Also, contaminants present in the air can be deposited on the insulator surface. To avoid these problems, never touch the connector insulating material. In addition, the multiplexer card should be used only in clean, dry environments to avoid contamination.

If the connector insulators should become contaminated, either by inadvertent touching, or from air-borne deposits, they can be cleaned with a cotton swab dipped in clean methanol. After thoroughly cleaning, they should be allowed to dry for several hours in a low-humidity environment before use, or they can be dried more quickly using dry nitrogen.

4.5.6 AC frequency response

The AC frequency response of the Model 7011 is important in test systems that switch AC signals. Refer to the specifications at the front of this manual.

5
Service Information

WARNING

The information in this section is intended only for qualified service personnel. Some of the procedures may expose you to hazardous voltages that could result in personal injury or death. Do not attempt to perform these procedures unless you are qualified to do so.

5.1 Introduction

This section contains information necessary to service the Model 7011 multiplexer card and is arranged as follows:

5.2 **Handling and cleaning precautions:** Discusses handling precautions and methods to clean the card should it become contaminated.

5.3 **Performance verification:** Covers the procedures necessary to determine if the card meets stated specifications.

5.4 **Special handling of static-sensitive devices:** Reviews precautions necessary when handling static-sensitive devices.

5.5 **Principles of operation:** Briefly discusses circuit operation.

5.6 **Troubleshooting:** Presents some troubleshooting tips for the Model 7011 including relay replacement precautions.

5.2 Handling and cleaning precautions

Because of the high-impedance areas on the Model 7011, care should be taken when handling or servicing the card to prevent possible contamination. The following precautions should be taken when servicing the card.

Handle the card only by the edges and shields. Do not touch any board surfaces or components not associated with the repair. Do not touch areas adjacent to electrical contacts. When servicing the card, wear clean cotton gloves.

Do not store or operate the card in an environment where dust could settle on the circuit board. Use dry nitrogen gas to clean dust off the board if necessary.

Should it become necessary to use solder on the circuit board, use an OA-based (organic activated) flux. Remove the flux from the work areas when the repair has been completed. Use pure water along with clean cotton swabs or a clean soft brush to remove the flux. Take care not to spread the flux to other areas of the circuit

board. Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.

After cleaning, the card should be placed in a 50°C low humidity environment for several hours before use.

5.3 Performance verification

The following paragraphs discuss performance verification procedures for the Model 7011, including path resistance, offset current, contact potential, and isolation.

With the Model 7011's backplane jumpers installed, the performance verification procedures must be performed with only one multiplexer card (the one being checked) installed in the Model 7001 mainframe. These conditions do not apply if the backplane jumpers are removed.

CAUTION

Contamination will degrade the performance of the card. To avoid contamination, always grasp the card by the side edges. Do not touch the connectors, and do not touch the board surfaces or components. On plugs and receptacles, do not touch areas adjacent to the electrical contacts.

NOTE

Failure of any performance verification test may indicate that the multiplexer card is contaminated. See paragraph 5.2 to clean the card.

5.3.1 Environmental conditions

All verification measurements should be made at an ambient temperature between 18° and 28°C, and at a relative humidity of less than 70%.

5.3.2 Recommended equipment

Table 5-1 summarizes the equipment necessary for performance verification, along with an application for each unit.

Table 5-1
Verification equipment

Description	Model or part	Specifications	Applications
DMM	Keithley Model 196	300Ω; 0.01%	Path resistance
Electrometer w/voltage source	Keithley Model 617	10pA, 100pA; 1.6% 100V source; 0.2%	Offset current, path isolation
Sensitive Digital Voltmeter	Keithley Model 182	3mV; 60ppm	Contact potential
Triax cable (unterminated)	Keithley Model 7025	—	Offset current
Low thermal cable (unterminated)	Keithley Model 1484	—	Contact potential

5.3.3 Multiplexer card connections

The following information summarizes methods that can be used to connect test instrumentation to the two connector cards. Detailed connection information is provided in Section 3.

Model 7011-S — Instrumentation can simply be hard-wired directly to the screw terminals of the connector card. Jumper wires should be kept as short as possible.

Model 7011-C — One method to make instrument connections to the multiplexer card is by hard-wiring a 96-pin female DIN connector then mating it to the connector on the Model 7011-C. Input and output shorting connections can also be done at the connector. The connector in the Model 7011-KIT-R connection kit (see Table 3-2) can be used for this purpose. Pin identification for the connector is provided by Figure 3-8.

CAUTION

After making solder connections to a connector, remove solder flux as explained in paragraph 5.2. Failure to clean the solder connections could result in degraded performance preventing the card from passing verification tests.

Before pre-wiring any connectors or plugs, study the following test procedures to fully understand the connection requirements.

5.3.4 Channel resistance tests

Perform the following steps to verify that each contact of every relay is closing properly and that the resistance is within specification.

1. Turn the Model 7001 off if it is on.
2. Turn on the Model 196, and allow it to warm up for one hour before making measurements.
3. Connect all input terminals of Bank A together to form one common terminal, as shown in Figure 5-1.
4. Set the Model 196 to the 300Ω range and connect the four test leads to the OHMS and OHMS SENSE input jacks.
5. Short the four test leads together and zero the Model 196. Leave zero enabled for the entire test.
6. Connect OHMS HI and OHMS SENSE HI of the Model 196 to the common terminal (jumper on Bank A inputs). It is recommended that the physical connections be made at inputs 1 and 10 of Bank A, as shown in Figure 5-1.
7. Connect OHMS LO and OHMS SENSE LO to the HI (H) terminal of Bank A.
8. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001.
9. Turn on the Model 7001 and program it to close Channel 1!1 (Bank A, Input 1). Verify that the resistance of this path is <1Ω.
10. Open Channel 1!1 and close Channel 1!2 (Bank A, Input 2). Verify that the resistance of this path is <1Ω.
11. Using the basic procedure in steps 9 and 10, check the resistance of Bank A HI (H) terminal paths for Inputs 3 through 10 (Channels 1!3 through 1!10).
12. Turn off the Model 7001 and move the OHMS LO and OHMS SENSE LO test leads to the LO (L) terminal of Bank A.
13. Repeat steps 9 through 11 to check the LO (L) terminal paths of Bank A (Channels 1!1 through 1!10).
14. Repeat the basic procedure in steps 1 through 13 for Banks B through D (Channels 1!11 through 1!40).

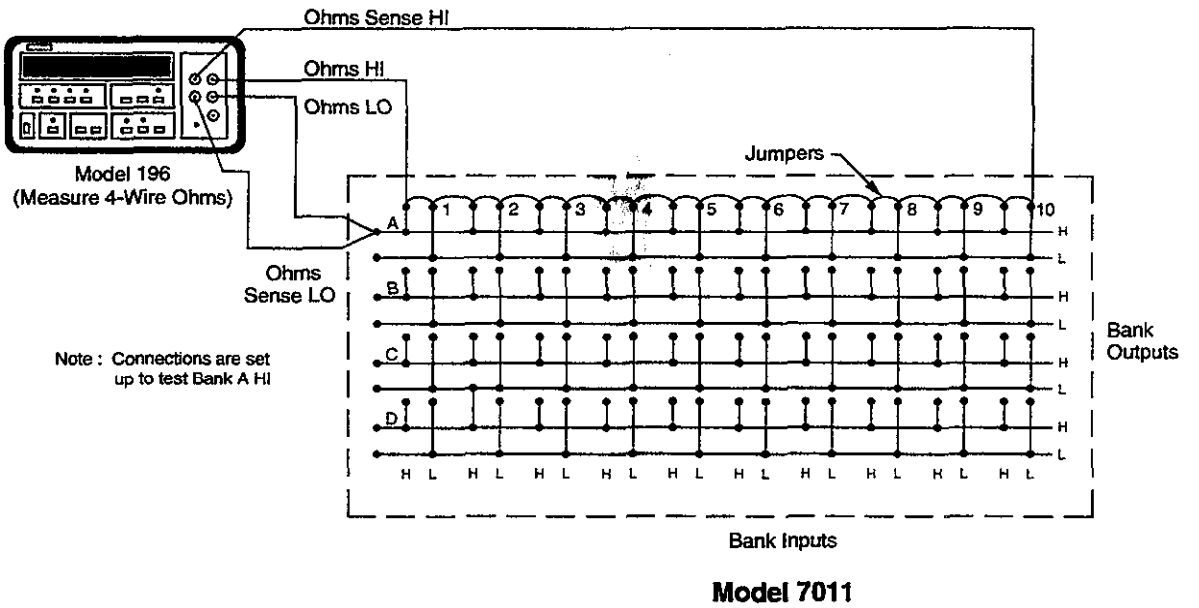


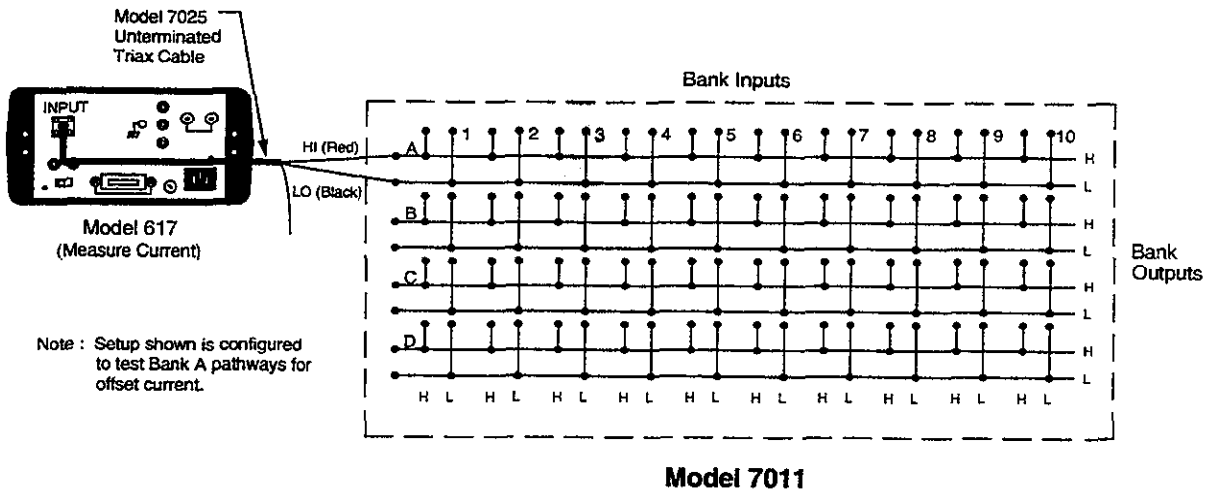
Figure 5-1
Path resistance test connections

5.3.5 Offset current tests

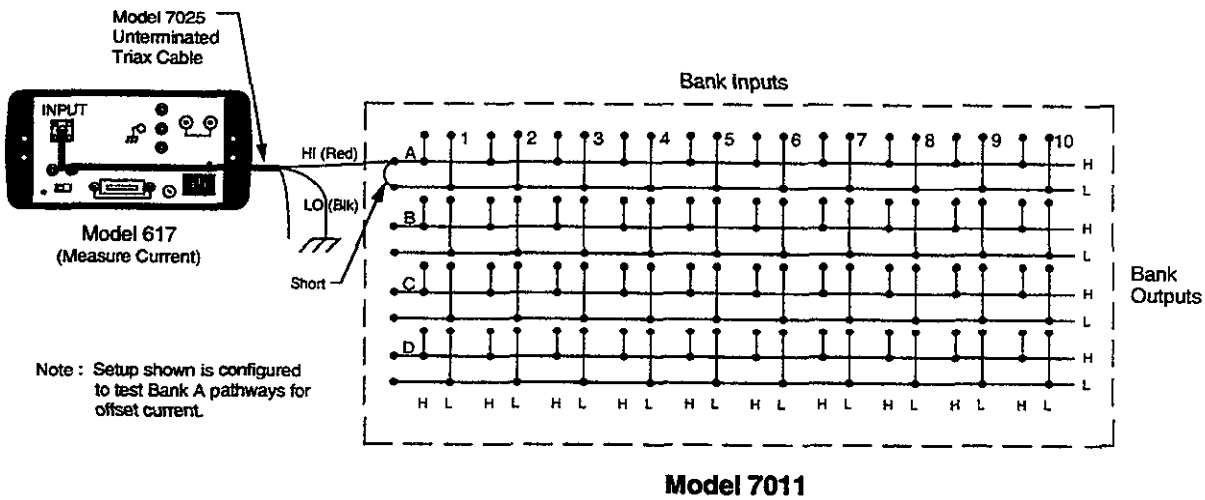
These tests check leakage current between HI (H) and LO (L) (differential offset current) and from HI (H) and LO (L) to chassis (common-mode offset current) of each pathway. In general, these tests are performed by simply measuring the leakage current with an electrometer. In the following procedure, the Model 617 is used to measure the leakage current. Test connections are shown in Figure 5-2.

Perform the following procedure to check offset current:

1. Turn the Model 7001 off if it is on, and remove any jumpers or wires connected to the multiplexer card.
2. Connect the triax cable to the Model 617, but do not connect it to the multiplexer card at this time.
3. Turn on the Model 617 and allow the unit to warm up for two hours before testing. After warm up, select the 200pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure. Also, be certain that V-Ω, GUARD is OFF and ground strap is connected to LO.
4. Connect the triax cable to Bank A HI and LO, as shown in Figure 5-2A.
5. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001.
6. Turn on the Model 7001 and program the unit to close Channel 1!1 (Bank A, Input 1).
7. On the Model 617, disable zero check and allow the reading to settle. Verify that the reading is <100pA. This specification is the offset (leakage) current of the pathway.
8. Enable zero check on the Model 617 and open Channel 1!1 from the front panel of the Model 7001.
9. Repeat the basic procedure in steps 6 through 8 to check the rest of the pathways (Inputs 2 through 10) of Bank A (Channels 1!2 through 1!10).
10. Turn off the Model 7001 and change the electrometer connections to Bank B.
11. Repeat the basic procedure in steps 6 through 10 to check Bank B, Inputs 1 through 10 (Channels 1!11 through 1!20).
12. Repeat the basic procedure in steps 6 through 11 for Banks C and D (Channels 1!21 through 1!40).
13. Turn off the Model 7001 and change the electrometer connections, as shown in Figure 5-2B. Note that electrometer HI is connected to HI and LO of the Bank A output, which are jumpered together. Electrometer LO is connected to chassis.
14. Repeat steps 6 through 12 to check that the common mode offset current is <100pA.



A) Differential



B) Common-Mode

Figure 5-2
Differential offset current test connections

5.3.6 Contact potential tests

These tests check the EMF generated by each relay contact pair (H and L) for each pathway. The tests simply consist of using a sensitive digital voltmeter (Model 182) to measure the contact potential.

Perform the following procedure to check contact potential of each path:

1. Turn the Model 7001 off if it is on.
2. Place jumpers between Banks A-B, B-C, and C-D.
3. Turn on the Model 182 and allow the unit to warm up to achieve rated accuracy.
4. Place a short between HI to LO on each input (Channels 1-40).
5. Place a short between HI to LO on output Bank D (long enough to cut with wire cutters).
6. Connect the Model 182 input leads to HI and LO output Bank A using copper wires.
7. Install the Model 7011 in the Model 7001 slot 1, and turn the Model 7001 on.
8. Allow Models 7001, 7011 and 182 to warm up for two hours.
9. Select the 3mV range on the Model 182.
10. Press REL READING (on the Model 182) to null out internal offsets. Leave REL READING enabled for the entire procedure.
11. Turn the Model 7001 off. Remove the Model 7011 from slot 1. Cut the short on B and D output HI to LO.
12. Install the Model 7011 in the Model 7001 slot 1, and turn power on.
13. Wait 15 minutes.
14. Program the Model 7001 to close Channel 1!1.
15. After settling, verify that reading on the Model 182 is <500nV (for the Model 7011-S). This measurement represents the contact potential of the pathway.
16. From the Model 7001, open Channel 1!1.
17. Repeat steps 12 through 14 for all 40 channels.

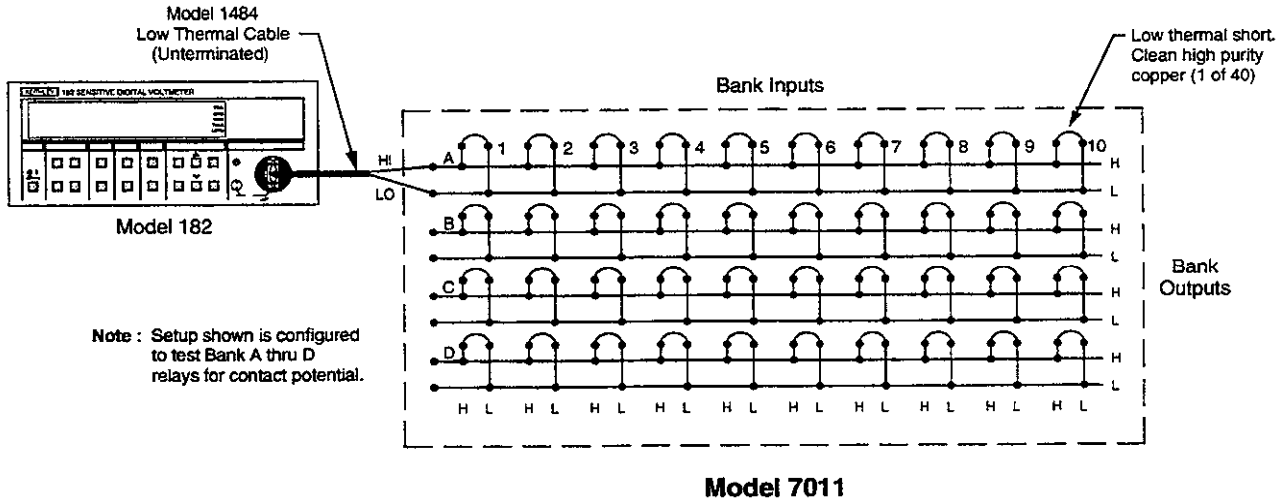


Figure 5-3
Contact potential test connections

5.3.7 Bank and channel-to-channel isolation tests

Bank isolation tests check the leakage resistance between adjacent banks. Channel-to-channel isolation tests check the leakage resistance between a Bank Output connection and a Bank Input connection with an adjacent Bank Input relay closed. In general, the tests are performed by applying a voltage (100V) across the leakage resistance and then measuring the current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as both a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels and displays the resistive value.

Perform the following steps to check bank and channel-to-channel isolation:

1. Turn the Model 7001 off if it is on, and remove any jumpers or test leads connected to the multiplexer card.
2. Turn on the Model 617 and allow the unit to warm up for two hours before testing.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
4. Connect the electrometer to the Model 7011, as shown in Figure 5-4.
5. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001 and turn the mainframe on.
6. On the Model 617, select the 20pA range and release zero check.
7. On the Model 617, press SUPPRESS to cancel offset current, then enable zero check.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

8. On the Model 617, set the voltage source for +100V, and select the 20nA current range. Make sure the voltage source is in standby.
9. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
10. Program the Model 7001 to close Channels 1!1 and 1!12 (Bank A, Input 1 and Bank B, Input 2).

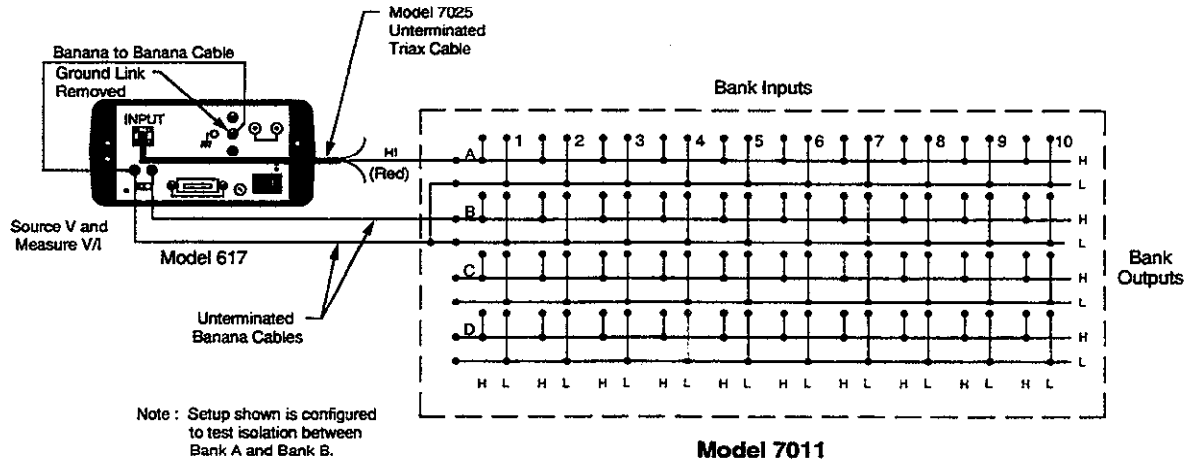


Figure 5-4
Bank isolation test connections

11. On the Model 617, disable zero check and press OPERATE to source +100V.
12. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$). This measurement is the leakage resistance (bank isolation) between Bank A, Input 1 and Bank B, Input 2.
13. Place the Model 617 voltage source in standby and enable zero check.
14. Turn off the Model 7001 and move the electrometer connections to Banks B and C.
15. Install the Model 7011 in slot 1 of the mainframe and turn the Model 7001 on.
16. Program the Model 7001 to close Channels 1!12 and 1!23 (Bank B, Input 2 and Bank C, Input 3).
17. On the Model 617, disable zero check and press OPERATE to source +100V.
18. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$).
19. Place the Model 617 voltage source in standby and enable zero check.
20. Turn off the Model 7001 and move the electrometer connections to Banks C and D.
21. Install the Model 7011 in slot 1 of the mainframe, and turn the Model 7001 on.
22. Using Table 5-2 as a guide, repeat the basic procedure of steps 16 through 18 for the rest of the path pairs (test numbers 3 through 9 in the table).
23. Place the Model 617 voltage source in standby and enable zero check.

NOTE

Refer to for the following procedure to check channel-to-channel isolation.

24. Turn off the Model 7001 and connect the Model 617 to the card as shown in Figure 5-5.
25. Install the Model 7011 in slot 1 of the Model 7001, and turn the mainframe on.
26. Program the Model 7001 to close Channel 1!2 (Bank A, Input 2). Make sure all other channels are open.
27. On the Model 617, disable zero check and press OPERATE to source 100V.
28. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$).
29. Place the Model 617 voltage source in standby, and enable zero check.
30. Using Table 5-3 as a guide, perform tests 2 through 9 for the remaining Bank A Inputs. Remember to move Bank Input connections as indicated in the table.
31. Use Table 5-3 (test numbers 10 through 36) and the above procedure to test Banks B, C, and D.

Table 5-2
Bank isolation test summary

Test number	Bank isolation	Test equipment location	Channels closed*
1	Bank A, Input 1 to Bank B, Input 2	Bank A and Bank B	1!1 and 1!12
2	Bank B, Input 2 to Bank C, Input 3	Bank B and Bank C	1!12 and 1!23
3	Bank C, Input 3 to Bank D, Input 4	Bank C and Bank D	1!23 and 1!34
4	Bank C, Input 4 to Bank D, Input 5	Bank C and Bank D	1!24 and 1!35
5	Bank C, Input 5 to Bank D, Input 6	Bank C and Bank D	1!25 and 1!36
6	Bank C, Input 6 to Bank D, Input 7	Bank C and Bank D	1!26 and 1!37
7	Bank C, Input 7 to Bank D, Input 8	Bank C and Bank D	1!27 and 1!38
8	Bank C, Input 8 to Bank D, Input 9	Bank C and Bank D	1!28 and 1!39
9	Bank C, Input 9 to Bank D, Input 10	Bank C and Bank D	1!29 and 1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

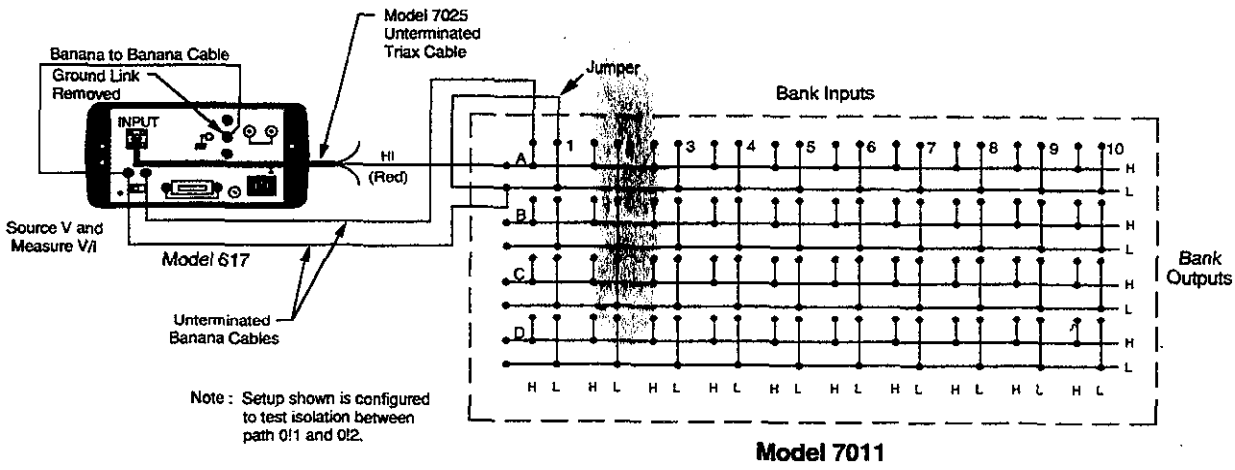


Figure 5-5
Channel-to-channel isolation test connections

Table 5-3
Channel-to-channel isolation test summary

Test number	Channel-to-channel isolation	Test equipment location	Channel closed*
1	Bank A, Input 1 to Bank A, Input 2	Bank A and Input 1	1!2
2	Bank A, Input 2 to Bank A, Input 3	Bank A and Input 2	1!3
3	Bank A, Input 3 to Bank A, Input 4	Bank A and Input 3	1!4
4	Bank A, Input 4 to Bank A, Input 5	Bank A and Input 4	1!5
5	Bank A, Input 5 to Bank A, Input 6	Bank A and Input 5	1!6
6	Bank A, Input 6 to Bank A, Input 7	Bank A and Input 6	1!7
7	Bank A, Input 7 to Bank A, Input 8	Bank A and Input 7	1!8
8	Bank A, Input 8 to Bank A, Input 9	Bank A and Input 8	1!9
9	Bank A, Input 9 to Bank A, Input 10	Bank A and Input 9	1!10
10	Bank B, Input 1 to Bank B, Input 2	Bank B and Input 1	1!12
11	Bank B, Input 2 to Bank B, Input 3	Bank B and Input 2	1!13
12	Bank B, Input 3 to Bank B, Input 4	Bank B and Input 3	1!14
13	Bank B, Input 4 to Bank B, Input 5	Bank B and Input 4	1!15
14	Bank B, Input 5 to Bank B, Input 6	Bank B and Input 5	1!16
15	Bank B, Input 6 to Bank B, Input 7	Bank B and Input 6	1!17
16	Bank B, Input 7 to Bank B, Input 8	Bank B and Input 7	1!18
17	Bank B, Input 8 to Bank B, Input 9	Bank B and Input 8	1!19
18	Bank B, Input 9 to Bank B, Input 10	Bank B and Input 9	1!20
19	Bank C, Input 1 to Bank C, Input 2	Bank C and Input 1	1!22
20	Bank C, Input 2 to Bank C, Input 3	Bank C and Input 2	1!23
21	Bank C, Input 3 to Bank C, Input 4	Bank C and Input 3	1!24
22	Bank C, Input 4 to Bank C, Input 5	Bank C and Input 4	1!25
23	Bank C, Input 5 to Bank C, Input 6	Bank C and Input 5	1!26
24	Bank C, Input 6 to Bank C, Input 7	Bank C and Input 6	1!27
25	Bank C, Input 7 to Bank C, Input 8	Bank C and Input 7	1!28
26	Bank C, Input 8 to Bank C, Input 9	Bank C and Input 8	1!29
27	Bank C, Input 9 to Bank C, Input 10	Bank C and Input 9	1!30
28	Bank D, Input 1 to Bank D, Input 2	Bank D and Input 1	1!32
29	Bank D, Input 2 to Bank D, Input 3	Bank D and Input 2	1!33
30	Bank D, Input 3 to Bank D, Input 4	Bank D and Input 3	1!34
31	Bank D, Input 4 to Bank D, Input 5	Bank D and Input 4	1!35
32	Bank D, Input 5 to Bank D, Input 6	Bank D and Input 5	1!36
33	Bank D, Input 6 to Bank D, Input 7	Bank D and Input 6	1!37
34	Bank D, Input 7 to Bank D, Input 8	Bank D and Input 7	1!38
35	Bank D, Input 8 to Bank D, Input 9	Bank D and Input 8	1!39
36	Bank D, Input 9 to Bank D, Input 10	Bank D and Input 9	1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

5.3.8 Differential and common-mode isolation tests

These tests check the leakage resistance (isolation) between HI (H) and LO (L) (differential), and from HI (H) and LO (L) to chassis (common-mode) of every bank and channel. In general, the test is performed by applying a voltage (100V) across the terminals and then measuring the leakage current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels, and displays the resistance value.

Perform the following steps to check differential and common mode isolation:

1. Turn the Model 7001 off if it is on, and remove any jumpers and test leads connected to the multiplexer card.
2. Turn on the Model 617 and allow the unit to warm up for two hours for rated accuracy.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

4. On the Model 617, set the voltage source for +100V, and select the 200nA current range. Make sure the voltage source is still in standby.
5. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
6. With the Model 617 in standby, connect the electrometer to Bank A of the multiplexer card, as shown in Figure 5-6.
7. Install the Model 7011 in slot 1 (CARD 1) of the mainframe, and turn the Model 7001 on.
8. Make sure all the relays are open. (Press OPEN ALL on the Model 7001.)
9. On the Model 617, disable zero check, and press OPERATE to source 100V.
10. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$). This measurement is the differential leakage resistance (isolation) of Bank A.
11. Place the Model 617 in standby and enable zero check.

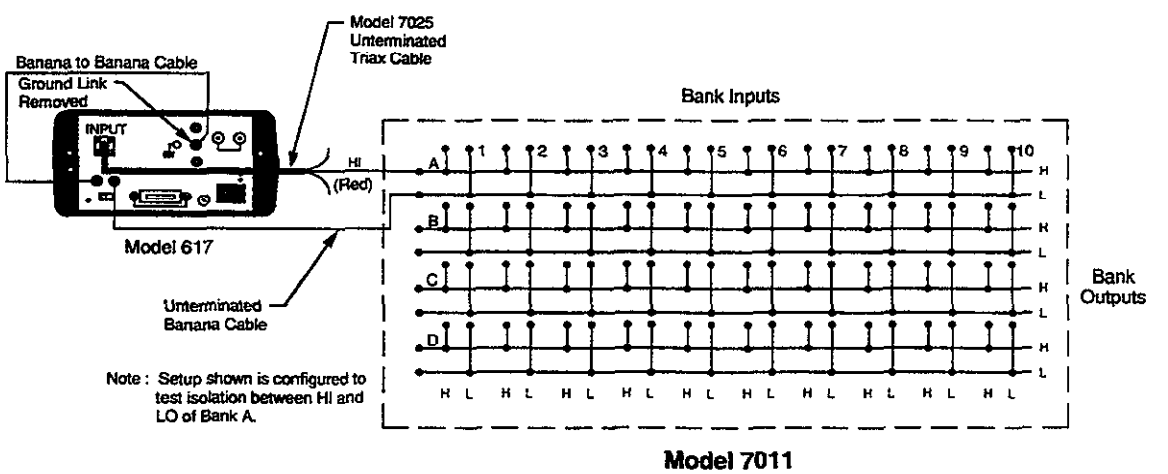


Figure 5-6
Differential isolation test connections

12. Program the Model 7001 to close Channel 1!1 (Bank A, Input 1).
13. On the Model 617, disable zero check and press OPERATE to source +100V.
14. After allowing the reading on the Model 617 to settle, verify that it is also >1GΩ (10^9Ω). This measurement checks the differential isolation of Input 1.
15. Using Table 5-4 as a guide, repeat the basic procedure in steps 11 through 14 to test Inputs 2 through 10 of Bank A (test numbers 3 through 11 of the table).
16. Use Table 5-4 (test numbers 12 through 42) and the above procedure to test Banks B, C and D.
17. Place the Model 617 voltage source in standby and enable zero check.

NOTE

Refer to Figure 5-7 for the following procedure to check common mode isolation.

18. Turn off the Model 7001, and connect the electrometer to the Model 7011 as shown in Figure 5-7.
19. Repeat steps 4 through 16 to check common mode isolation. Verify that each reading is >1GΩ (10^9Ω).

Table 5-4
Differential and common-mode isolation testing

Test number	Differential or common mode isolation	Channel closed*
1	Bank A	None
2	Bank A, Input 1	1!1
3	Bank A, Input 2	1!2
4	Bank A, Input 3	1!3
5	Bank A, Input 4	1!4
6	Bank A, Input 5	1!5
7	Bank A, Input 6	1!6
8	Bank A, Input 7	1!7
9	Bank A, Input 8	1!8
10	Bank A, Input 9	1!9
11	Bank A, Input 10	1!10
12	Bank B	None
13	Bank B, Input 1	1!11
14	Bank B, Input 2	1!12
15	Bank B, Input 3	1!13
16	Bank B, Input 4	1!14
17	Bank B, Input 5	1!15
18	Bank B, Input 6	1!16
19	Bank B, Input 7	1!17
20	Bank B, Input 8	1!18
21	Bank B, Input 9	1!19
22	Bank B, Input 10	1!20
23	Bank C	None
24	Bank C, Input 1	1!21
25	Bank C, Input 2	1!22
26	Bank C, Input 3	1!23
27	Bank C, Input 4	1!24
28	Bank C, Input 5	1!25
29	Bank C, Input 6	1!26
30	Bank C, Input 7	1!27
31	Bank C, Input 8	1!28
32	Bank C, Input 9	1!29
33	Bank C, Input 10	1!30
34	Bank D	None
35	Bank D, Input 1	1!31
36	Bank D, Input 2	1!32
37	Bank D, Input 3	1!33
38	Bank D, Input 4	1!34
39	Bank D, Input 5	1!35
40	Bank D, Input 6	1!36
41	Bank D, Input 7	1!37
42	Bank D, Input 8	1!38
43	Bank D, Input 9	1!39
44	Bank D, Input 10	1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

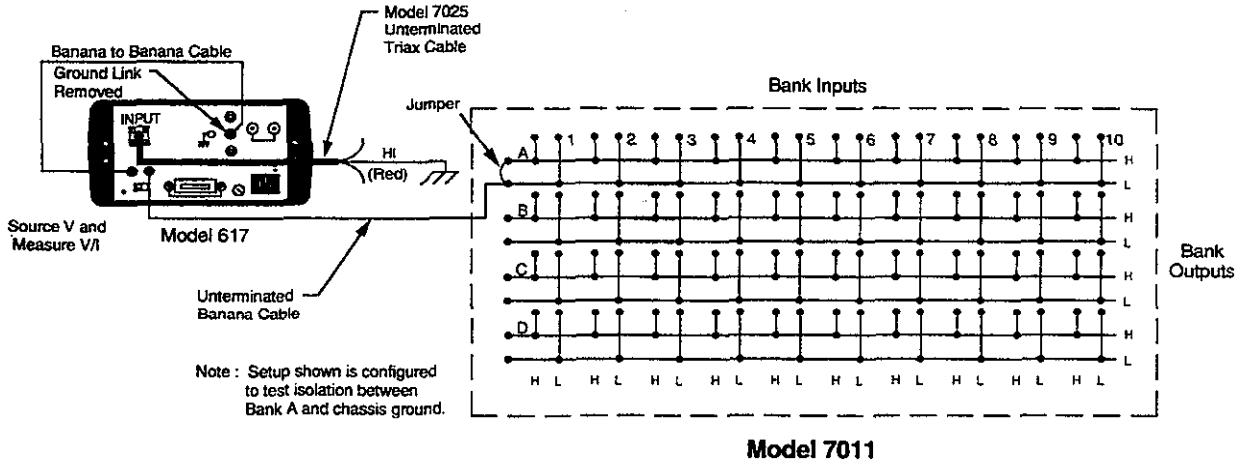


Figure 5-7
Common-mode isolation test connections

5.4 Special handling of static-sensitive devices

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved. When handling such devices, use the precautions listed below.

NOTE

In order to prevent damage, assume that all parts are static-sensitive.

1. Such devices should be transported and handled only in containers specially designed to prevent or dissipate static build-up. Typically, these devices will be received in anti-static containers made of plastic or foam. Keep these parts in their original containers until ready for installation or use.
2. Remove the devices from their protective containers only at a properly-grounded workstation. Also, ground yourself with an appropriate wrist strap while working with these devices.
3. Handle the devices only by the body; do not touch the pins or terminals.
4. Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.
5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

5.5 Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7011, and can be used as an aid in troubleshooting the card. The schematic drawing of the card is shown on drawing number 7011-106, located at the end of Section 6.

5.5.1 Block diagram

Figure 5-8 shows a simplified block diagram of the Model 7011. Key elements include the relay drivers and relays, as well as the ROM, which contains card ID and configuration information. These various elements are discussed in the following paragraphs.

5.5.2 ID data circuits

Upon power-up, card identification information from each card is read by the mainframe. This ID data includes such information as card ID, hardware settling time, and relay configuration information.

ID data is contained within an on-card EEPROM (U105). In order to read this information, the sequence described below is performed on power-up.

1. The IDDATA line (pin 6 of U105) is set from high to low while the IDCLK line (pin 5 of U105) is held high. This action initiates a start command to the ROM to transmit data serially to the mainframe (Figure 5-9).
2. The mainframe sends the ROM address location to be read over the IDDATA line. The ROM then transmits an acknowledge signal back to the mainframe, and it then transmits data at that location back to the mainframe (Figure 5-10).
3. The mainframe then transmits an acknowledge signal, indicating that it requires more data. The ROM will then sequentially transmit data after each acknowledge signal it receives.
4. Once all data is received, the mainframe sends a stop command, which is a low-to-high transition of the IDDATA line with the IDCLK line held high (see Figure 5-9).

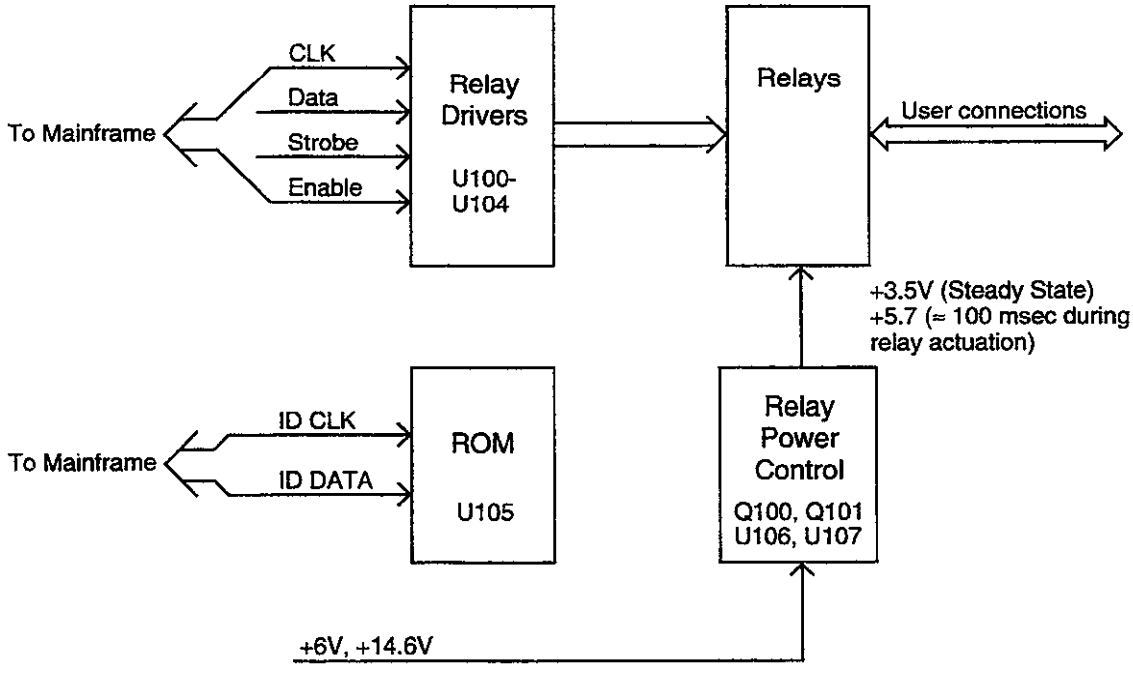


Figure 5-8
Model 7011 block diagram

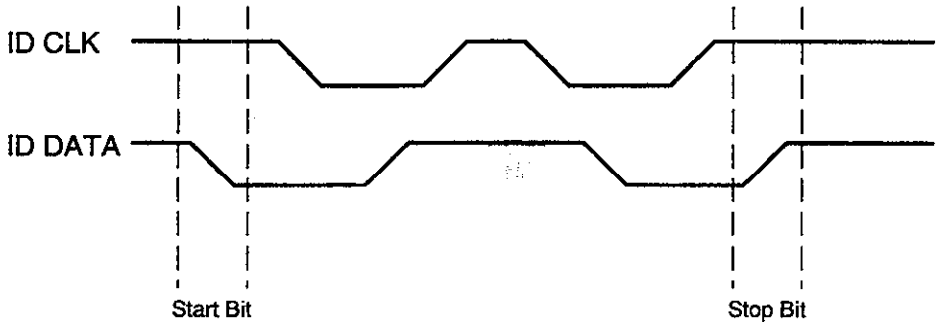


Figure 5-9
Start and stop sequences

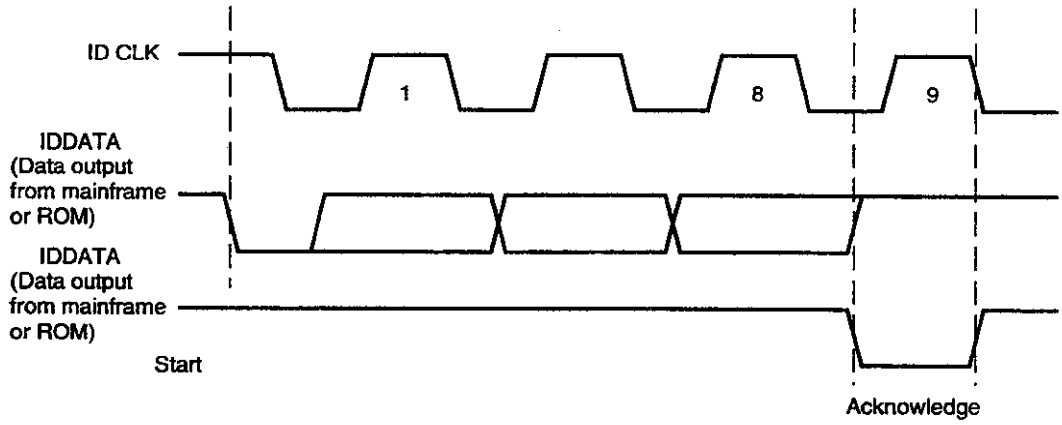


Figure 5-10
Transmit and acknowledge sequence

5.5.3 Relay control

Card relays are controlled by serial data transmitted via the relay DATA line. A total of five bytes for each card are shifted in serial fashion into latches located in the card relay driver ICs. The serial data is clocked in by the CLK line. As data overflows one register, it is fed out the Q'S line of the register down the chain.

Once all five bytes have shifted into the card, the STROBE line is set high to latch the relay information into the Q outputs of the relay drivers, and the appropriate relays are energized (assuming the driver outputs are enabled, as discussed below). Note that a relay driver output goes low to energize the corresponding relay.

5.5.4 Relay power control

A relay power control circuit, made up of U106, U107, Q100, Q101, and associated components, keeps power dissipated in relay coils at a minimum, thus reducing possible problems caused by thermal EMFs.

During steady-state operation, the relay supply voltage, +V, is regulated to +3.5V to minimize coil power dissipation. When a relay is first closed, the STROBE pulse applied to U106 changes the parameters of the relay supply voltage regulator, Q100, allowing the relay supply voltage, +V, to rise to +5.7V for about 100msec. This brief voltage rise ensures that relays close as quickly as possible. After the 100msec period has elapsed, the relay supply voltage (+V) drops back down to its nominal steady-state value of +3.5V.

5.5.5 Power-on safeguard

NOTE

The power-on safeguard circuit discussed below is actually located on the digital board in the Model 7001 mainframe.

A power-on safeguard circuit, made up of U114 (a D-type flip-flop) and associated components ensures that relays do not randomly energize on power-up and power-down. This circuit disables all relays (all relays are open) during power-up and power-down periods.

The PRESET line on the D-type flip-flop is controlled by the 68302 microprocessor, while the CLK line of the D-type flip-flop is controlled by a VIA port line on the 68302 processor. The Q output of the flip-flop drives each switch card relay driver IC enable pin (U100-U104, pin 8).

When the 68302 microprocessor is in the reset mode, the flip-flop PRESET line is held low, and Q out immediately goes high, disabling all relays (relay driver IC enable pins are high, disabling the relays). After the reset condition elapses (≈200msec), PRESET goes high while Q out stays high. When the first valid STROBE pulse occurs, a low logic level is clocked into the D-type flip-flop, setting Q out low and enabling all relay drivers simultaneously. Note that Q out stays low, (enabling relay drivers) until the 68302 processor goes into a reset condition.

5.6 Troubleshooting

5.6.1 Troubleshooting equipment

Table 5-5 summarizes recommended equipment for troubleshooting the Model 7011.

Table 5-5
Recommended troubleshooting equipment

Description	Manufacturer and model	Application
Multimeter	Keithley 196	Measure DC voltages
Oscilloscope	TEK 2243	View logic waveforms

5.6.2 Troubleshooting access

In order to gain access to the relay card top surface to measure voltages under actual operation conditions, perform the following steps:

1. Disconnect the connector card from the relay card.
2. Remove the Model 7001 cover.
3. Install the relay card in the CARD 1 slot location.
4. Turn on Model 7001 power to measure voltages (see following paragraph).

5.6.3 Troubleshooting Procedure

Table 5-6 summarizes switch card troubleshooting.

WARNING

Lethal voltages are present within the 7001 mainframe. Some of the procedures may expose you to hazardous voltages. Observe standard safety precautions for dealing with live circuits. Failure to do so could result in personal injury or death.

CAUTION

Observe the following precautions when troubleshooting or repairing the switch card:

To avoid contamination, which could degrade card performance, always handle the card only by the handle and side edges. Do not touch edge connectors, board surfaces, or components on the card. Also, do not touch areas adjacent to electrical contacts on connectors.

Use care when removing relays from the PC board to avoid pulling traces away from the circuit board. Before attempting to remove a relay, use an appropriate de-soldering tool, such as a solder sucker, to clear each mounting hole completely free of solder. Each relay pin must be free to move in its mounting hole before removal. Also, make certain that no burrs are present on the ends of the relay pins.

Table 5-6
Troubleshooting procedure

Step	Item/component	Required condition	Comments
1	GND pad		All voltages referenced to digital ground (GND pad).
2	+6V pad	+6VDC	Relay voltage.
3	+5V pad	+5VDC	Logic voltage.
4	+14.6V pad	+14.6VDC	Relay bias voltage.
5	+V pad	+3.5VDC*	Regulated relay voltage.
6	U105, pin 5	ID CLK pulses	During power-up only.
7	U105, pin 6	ID DATA pulses	During power-up only.
8	U100, pin 7	STROBE pulse	End of relay update sequence.
9	U100, pin 2	CLK pulses	During relay update sequence only.
10	U100, pin 3	DATA pulses	During relay update sequence only.
11	U100-U104, pins 10-18	Low with relay energized; high with relay de-energized.	Relay driver outputs.

*+3.5VDC present at +V pad under steady-state conditions. This voltage rises to +5.7VDC for about 100msec when relay configuration is changed.

6
Replaceable Parts

6.1 Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7011.

6.2 Parts lists

Parts lists for the various circuit boards are included in tables integrated with schematic diagrams and component layout drawings for the boards. Parts are listed alphabetically in order of circuit designation.

6.3 Ordering information

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory (see inside front cover for addresses). When ordering parts, be sure to include the following information:

1. Card model number 7011
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

6.4 Factory service

If the card is to be returned to Keithley Instruments for repair, perform the following:

1. Complete the service form at the back of this manual and include it with the card.
2. Carefully pack the card in the original packing carton.
3. Write ATTENTION REPAIR DEPT on the shipping label.

Note: It is not necessary to return the matrix mainframe with the card.

6.5 Component layouts and schematic diagrams

Component layout drawings and schematic diagrams are included on the following pages integrated with the parts lists:

Table 1 Parts List, Relay Card for 7011-S and 7011-C.
7011-100 Component Layout, Relay Card for 7011-S and 7011-C.
7011-106 Schematic, Relay Card for 7011-S and 7011-C.

NOTE

The Model 7011 and 7012 use the same relay card, only the connector cards are different.

Table 2 Parts List, Screw Terminated Connector Card for 7011-S.
7011-160 Component Layout, Screw Terminated Connector Card for 7011-S.
7011-166 Schematic, Screw Terminated Connector Card for 7011-S.

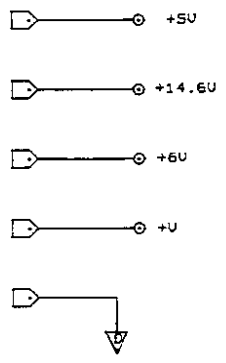
Table 3 Parts List, Mass Terminated Connector Card for 7011-C.
7011-170 Component Layout, Mass Terminated Connector Card for 7011-C.
7011-176 Schematic, Mass Terminated Connector Card for 7011-C.

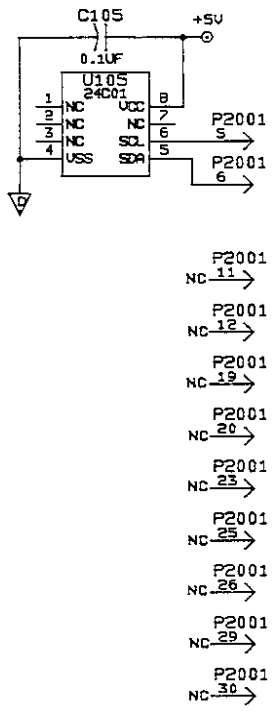
Table 6-1
Relay Board for Model 7011-S and 7011-C, Parts List

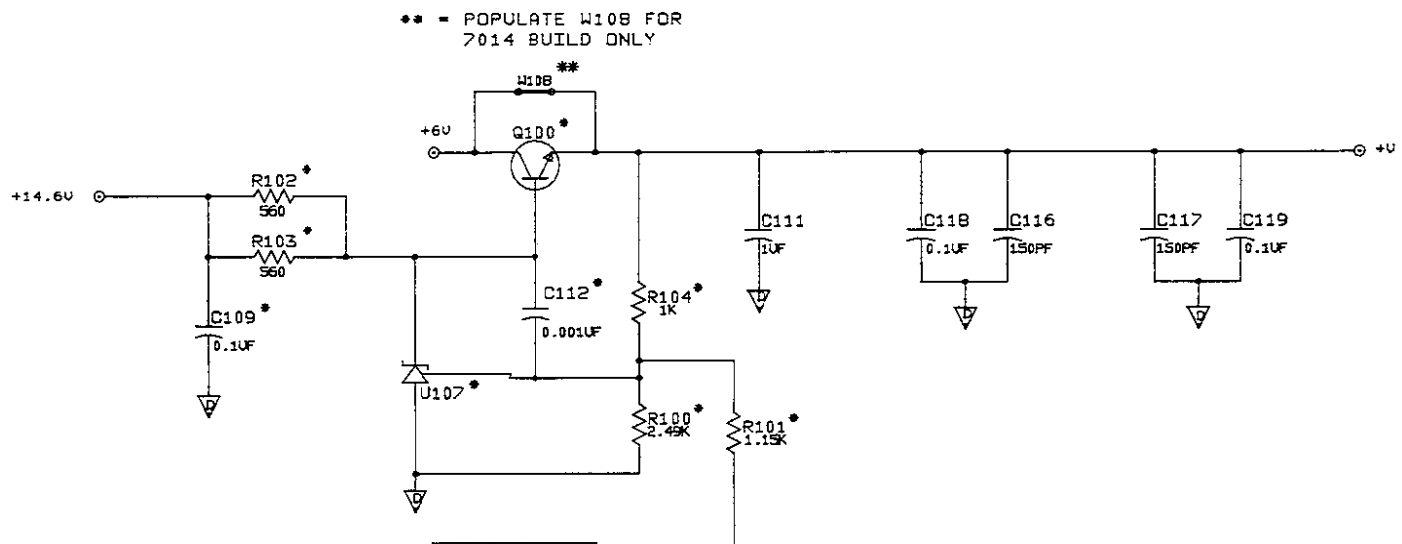
Circuit Desig.	Description	Keithley Part No.
	EJECTOR ARM	7011-301
	ROLL PIN (FOR EJECTOR ARMS)	DP-6-1
	SHIELD	7011-305
	SOCKET (FOR U105)	SO-72
C100-109,118,119	CAP,.1UF,20%,50V,CERAMIC	C-365.1
C110,111	CAP,1UF,20%,50V,CERAMIC	C-237-1
C112	CAP,0.001UF,20%,500V,CERAMIC	C-22-.001
C113,114	CAP,10UF,-20+100%,25V,ALUM ELEC	C-314-10
C115-117	CAP,150PF,10%,1000V,CERAMIC	C-64-150P
J1002,1003	CONNECTOR, MALE	CS-736-2
K100-139	RELAY, ULTRA-SMALL POLARIZED TF2E-5V	RL-149
P2001	CONNECTOR, RIGHT ANGLE MALE	CS-775-1
Q100	TRANS, NPN PWR, TIP31, (TO-220AB)	TG-253
Q101	TRANS,N CHAN MOSPOW FET,V11713 (TO-92)	TG-195
R100	RES, 2.49K, 1%, 1/8W, METAL FILM	R-88-2.49K
R101	RES, 1.15K, 1%, 1/8W, METAL FILM	R-88-1.15K
R102,103	RES, 560, 10%, 1/2W, COMPOSITION	R-1-560
R104	RES,1K,1%,1/8W,METAL FILM	R-88-1K
R105	RES,220K, 5%,1/4W,COMPOSITION OR FILM	R-76-220K
R106,107	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
U100-104	IC, 8-BIT SERIAL-IN LATCH DRIVER, 5841A	IC-536
U105	EPROM PROGRAM	7011-800-***
U106	IC,RETRIG MONO MULTIVIB,74HC123	IC-492
U107	IC,AJD SHUNT REGULATOR,TL431CLP	IC-677
W100-107	JUMPER	J-15

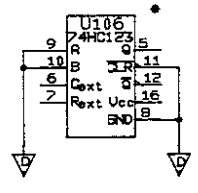
***Order current firmware revision level.

** = POPULATE W108 FOR
7014 BUILD ONLY









* = PARTS NOT USED ON 7014-102 BUILD,
R100, R101, R102, R103, R104, R105,
Q100, Q101, U106, U107, C109, C110, & C112.

KEITHLEY — KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

TITLE
SCHEMATIC
GENERAL PURPOSE SCANNER CARD

SCALE	MODEL	NO	ECO	REV
D	7011	7011-106		D1
DRAWN	APPROVED	DATE		
KEK		8/16/92		

SHEET 2 OF 2

CH10 CH9 CH8 CH7 CH6 CH5 CH4 CH3 CH2 CH1

K109 K108 K107 K106 K105 K104 K103 K102 K101 K100
K119 K118 K117 K116 K115 K114 K113 K112 K111 K110
K129 K128 K127 K126 K125 K124 K123 K122 K121 K120
K139 K138 K137 K136 K135 K134 K133 K132 K131 K130

W100 W101 W102 W103 W104 W105 W106 W107

P2001 17 P2001 18 P2001 21 P2001 22 P2001 27 P2001 28 P2001 31 P2001 32

U100 UCN-5841A U101 UCN-5841A U102 UCN-5841A U103 UCN-5841A U104 UCN-5841A

OE STR DATA CLK Q'S Vdd Vss V_EE V_CC

C100 C101 C102 C103 C104 0.1UF

C107 0.1UF C114 10UF C108 0.1UF C113 10UF R107 10K

+5V +6V +14.6V +V NC STROBE

P2001 1 P2001 2 P2001 3 P2001 4 P2001 5 P2001 6 P2001 7 P2001 8 P2001 9 P2001 10 P2001 11 P2001 12 P2001 13 P2001 14 P2001 15 P2001 16 P2001 24

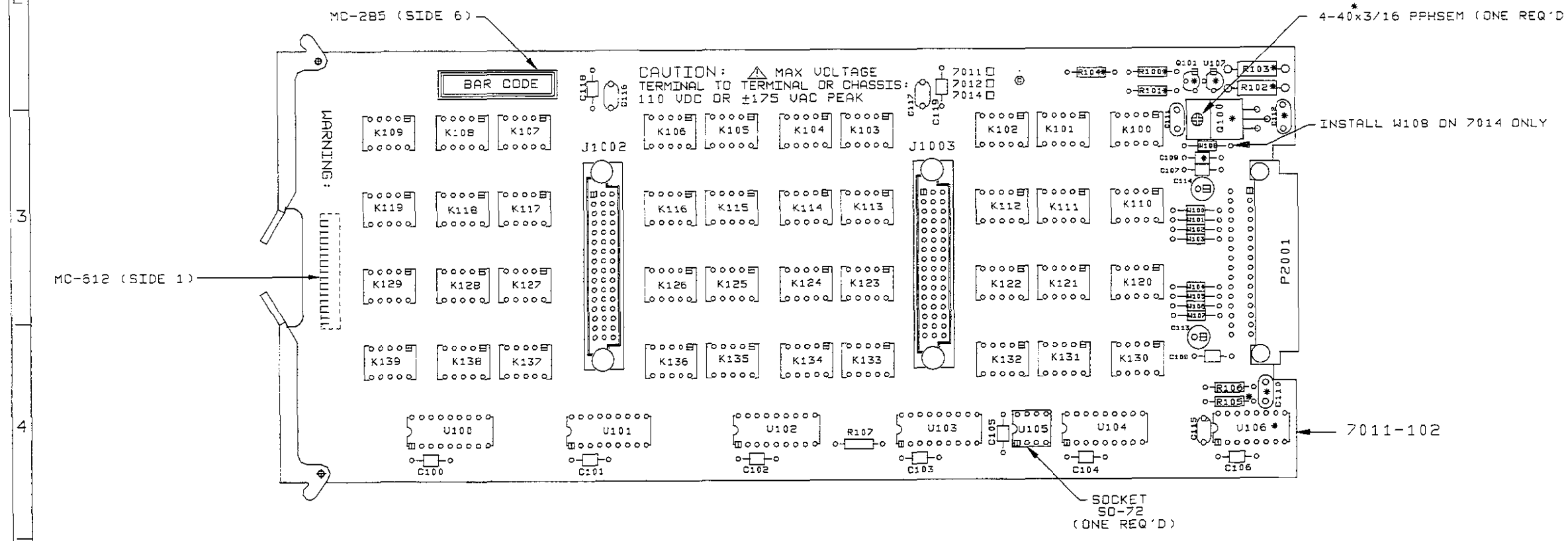
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139

TITLE
SCHEMATIC
GENERAL PURPOSE SCANNER CARD

SIZE D | MODEL 7011 | NO 7011-106 | ECO | REV D1
DRAWN KEK | APPROVED | DATE 8/16/92

SHEET 1 OF 2

LTR.	ECO NO.	REVISION	ENG.	DATE
B		PRELIMINARY		
C	910920	RELEASED	MS	9-20-91
D	15129	DELETED 2-56x3/8PPH(2REQ'D)	S2	8-5-92
D1	15453	ADDED MC-612, CHART FOR 7014, AND NOTE TO INSTALL W108 TO 7014 ONLY		9-1-92



* FOR 7014 BUILD, DO NOT INSTALL THE FOLLOWING PARTS			
R100	Q100	U106	C109
R101	Q101	U107	C110
R102			C112
R103			
R104		4-40X3/16PPHSEM	
R105			

NOTE: FOR COMPONENT INFORMATION, REFER TO PRODUCT STRUCTURE FOR 7011, 7012 AND 7014

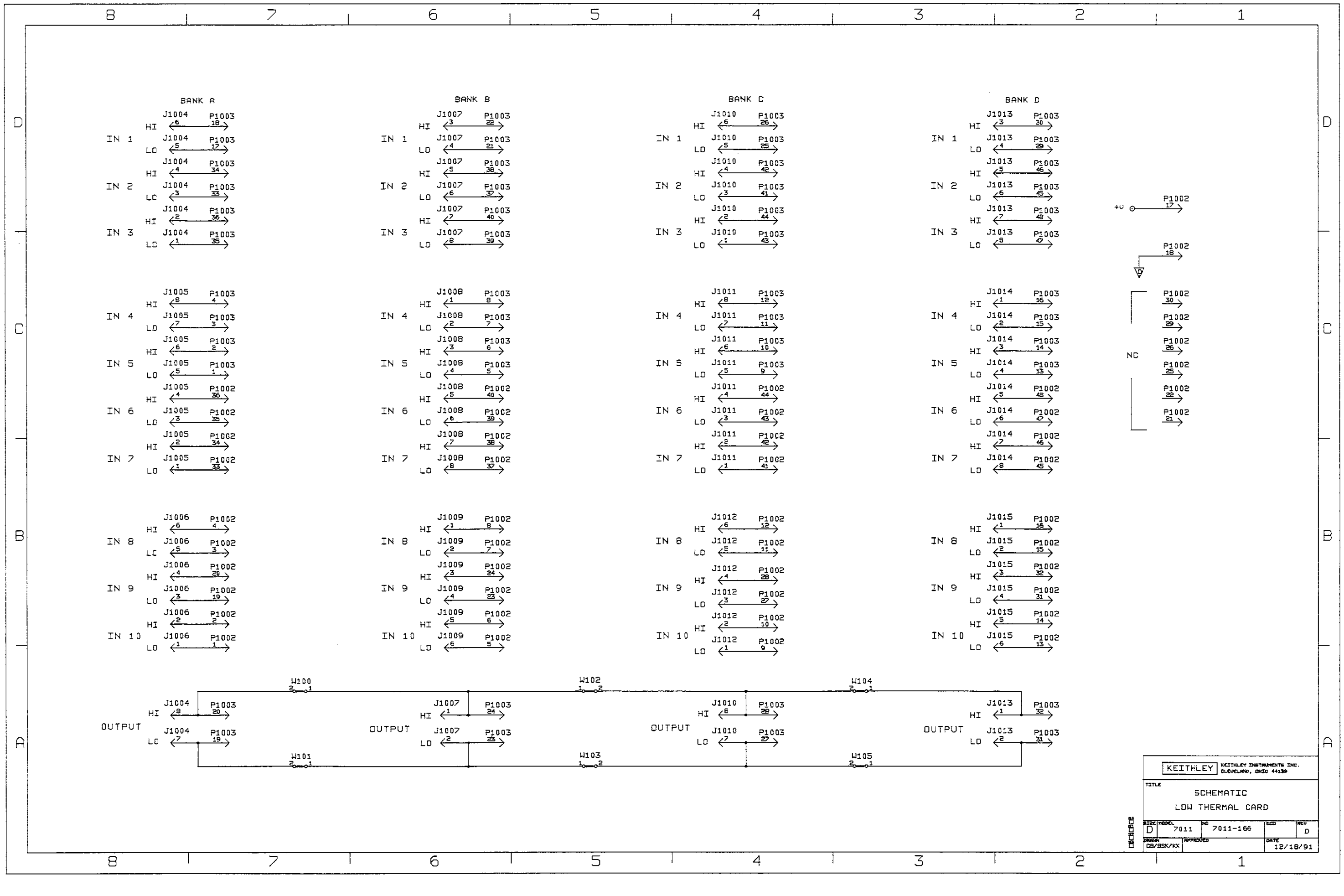
MODEL	NEXT ASSEMBLY	QTY.
7014	7011-101	1
7012	7011-101	1
7011	7011-101	1

USED ON

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8/12/91	SCALE 5:4	TITLE COMPONENT LAYOUT SCANNER BOARD
	XX=±.015 ANG.=±1°	DRN. KEK	ENG. APPR.	
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XXX=±.005 FRAC.=±1/64	MATERIAL		C NO. 7011-100
	SURFACE MAX. 63	FINISH		

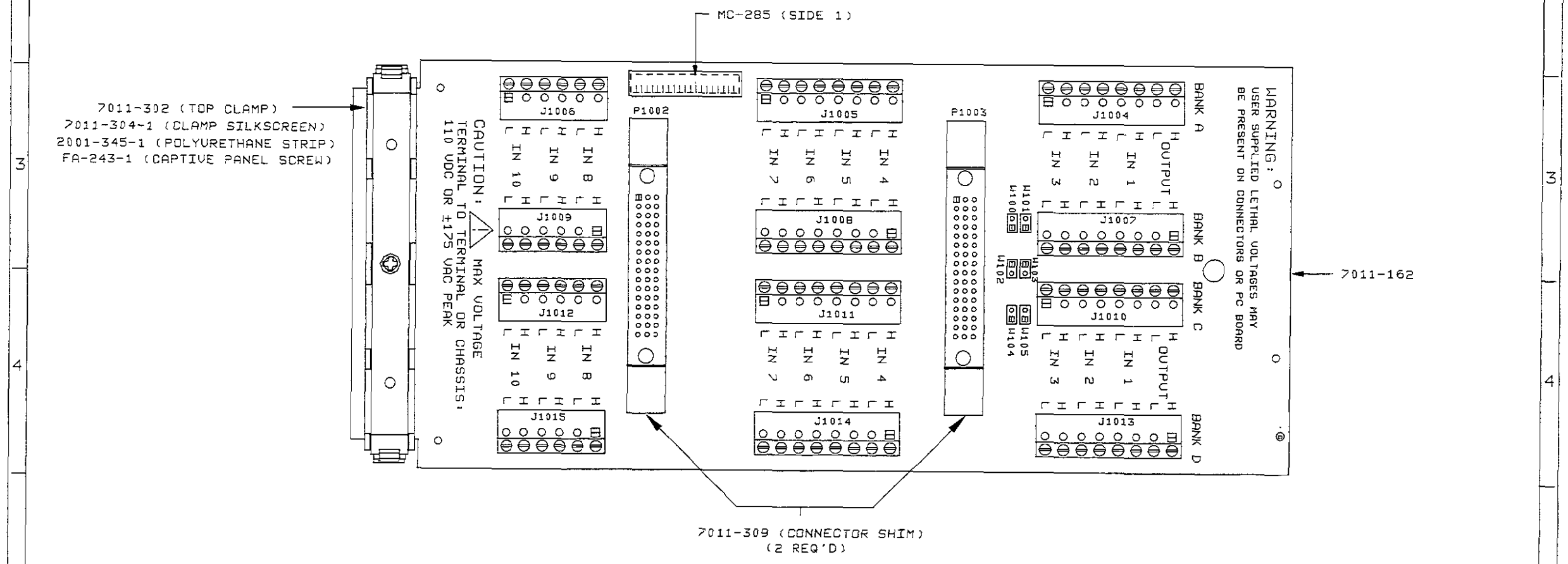
Table 6-2
Screw Terminal Board for Model 7011-S, Parts List

Circuit Desig.	Description	Keithley Part No.
	CABLE CLAMP	7011-304-1
	CAPTIVE SCREW (FOR TOP CLAMP)	FA-243-1
	CONNECTOR, JUMPER (FOR CS-339-2)	CS-476
	CONNECTOR SHIM (FOR P1002, 1003)	7011-309
	SHIELD	7011-305
	STRIP, POLYURETHANE (FOR BOTTOM CLAMP)	2001-345-1
	TOP CLAMP	7011-302
J1004,1005,1007 1008,1010, 1011, 1013,1014	CONN, 8 PIN	TE-115-8
J1006,1009,1012, 1015	CONN, 6-PIN	TE-115-6
P1002,1003	CONNECTOR, 48-PIN, 3 ROWS	CS-748-3
W100-105	CONN,BERG, 2 PIN	CS-339-2


BANK A
BANK B
BANK C
BANK D
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
HI
LO
J1004
J1005
J1006
J1007
J1008
J1009
J1010
J1011
J1012
J1013
J1014
J1015
P1003
P1002
+U
NC
OUTPUT
W100
W101
W102
W103
W104
W105
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
TITLE
SCHEMATIC
LOW THERMAL CARD
SIZE D
MODEL 7011
IND 7011-166
ECO
REV D
DRAWN CB/BSK/KK
APPROVED
DATE 12/18/91

NO. 7011-160

LTR.	ECO NO.	REVISION	ENG.	DATE
B		PRELIMINARY		
C	910920	RELEASED	MS	9-20-91
D	15129	REVISED		9-[illegible]-91



NOTE: FOR COMPONENT INFORMATION,
REFER TO PRODUCT STRUCTURE

MODEL	NEXT ASSEMBLY	QTY.
	USED ON	

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8/12/91	SCALE 5:4	TITLE COMPONENT LAYOUT TERMINAL BLOCK BOARD
KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. KEK	ENG. APPR.	
	XXX=±.005 FRAC.=±1/64	MATERIAL		NO. 7011-160
	SURFACE MAX. 63	FINISH		

Table 6-3
Mass Terminated Connector Board for Model 7011-C, Parts List

Circuit Desig.	Description	Keithley Part No.
	BRACKET	7011-307
	STANDOFF	ST-203-1
	SHIELD	7011-311
	CONNECTOR SHIM	7011-309
	CONN,BERG	CS-339
	CONNECTOR, JUMPER (FOR W100-105)	CS-476
C101,102	CAP,1UF,20%,50V, CERAMIC	C-237-1
C103	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
CR101-105	DIODE,SILICON,IN4148 (DO-35)	RF-28
E101,102	FERRITE BEAD	CT-8
J1004	CONN, 96-PIN, 3 ROWS	CS-514
K101-104	RLAY, ULTRA-SMALL POLARIZED TF2E-4.5V	RL-162
P1002,1003	CONNECTOR, FEMALE	CS-748-3
Q101-103	TRANS, N CHAN MOSPOW FET, V11713 (TO-92)	TG-195
R103,104	RES, 1M, 10%, 1/2W, COMPOSITION	R-1-1M
R105	RES, 39, 5%, 1/4W, COMPOSITION OR FILM	R-76-39
R106	RES,10,5%,1/4W,COMPOSITION OR FILM	R-76-10
R107	RES,4.99K,1%,1/8W,METAL FILM	R-88-4.99K
R108,110	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R109	RES,100K,5%,1/4W,COMPOSITION OR FILM	R-76-100K
R111	RES,10K,1%,1/8W,METAL FILM	R-88-10K
U101	IC,QUAD 2 INPUT NOR,74HC02	IC-412
U102	IC, DUAL COMP,LM393	IC-343
W100-105	CONN, BERG,2 PIN	CS-339-2

BANK A

IN 1	HI	J1004 96	P1003 18
	LO	J1004 64	P1003 17
IN 2	HI	J1004 32	P1003 34
	LO	J1004 95	P1003 33
IN 3	HI	J1004 63	P1003 36
	LO	J1004 31	P1003 35
IN 4	HI	J1004 94	P1003 4
	LO	J1004 62	P1003 3
IN 5	HI	J1004 30	P1003 2
	LO	J1004 93	P1003 1
IN 6	HI	J1004 61	P1002 36
	LO	J1004 29	P1002 35
IN 7	HI	J1004 92	P1002 34
	LO	J1004 60	P1002 33
IN 8	HI	J1004 28	P1002 4
	LO	J1004 91	P1002 3
IN 9	HI	J1004 59	P1002 20
	LO	J1004 27	P1002 19
IN 10	HI	J1004 90	P1002 2
	LO	J1004 58	P1002 1

BANK B

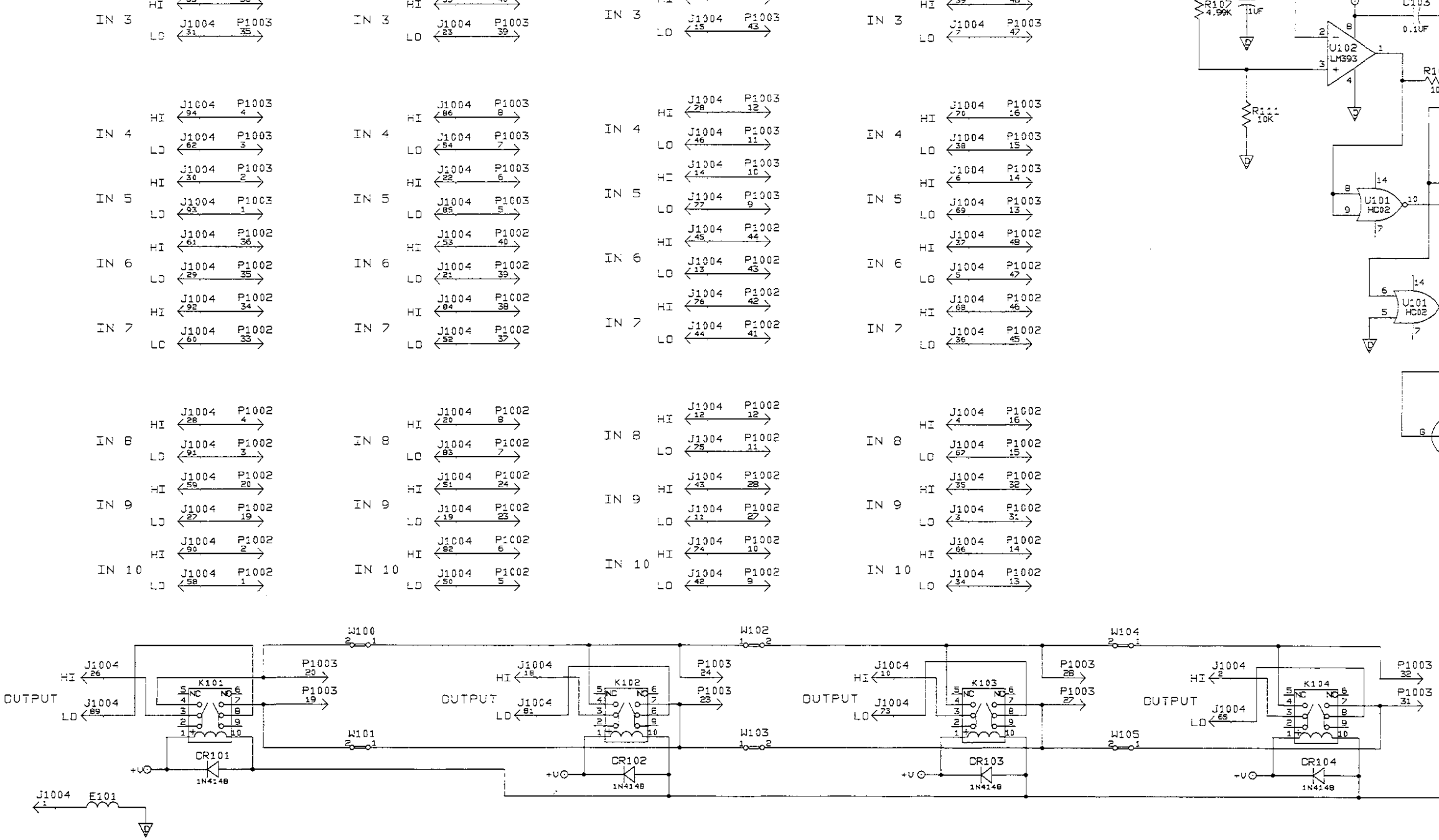
IN 1	HI	J1004 98	P1003 22
	LO	J1004 56	P1003 21
IN 2	HI	J1004 24	P1003 38
	LO	J1004 87	P1003 37
IN 3	HI	J1004 55	P1003 40
	LO	J1004 23	P1003 39
IN 4	HI	J1004 86	P1003 8
	LO	J1004 54	P1003 7
IN 5	HI	J1004 22	P1003 6
	LO	J1004 85	P1003 5
IN 6	HI	J1004 53	P1002 40
	LO	J1004 21	P1002 39
IN 7	HI	J1004 84	P1002 38
	LO	J1004 52	P1002 37
IN 8	HI	J1004 20	P1002 8
	LO	J1004 83	P1002 7
IN 9	HI	J1004 51	P1002 24
	LO	J1004 19	P1002 23
IN 10	HI	J1004 82	P1002 6
	LO	J1004 50	P1002 5

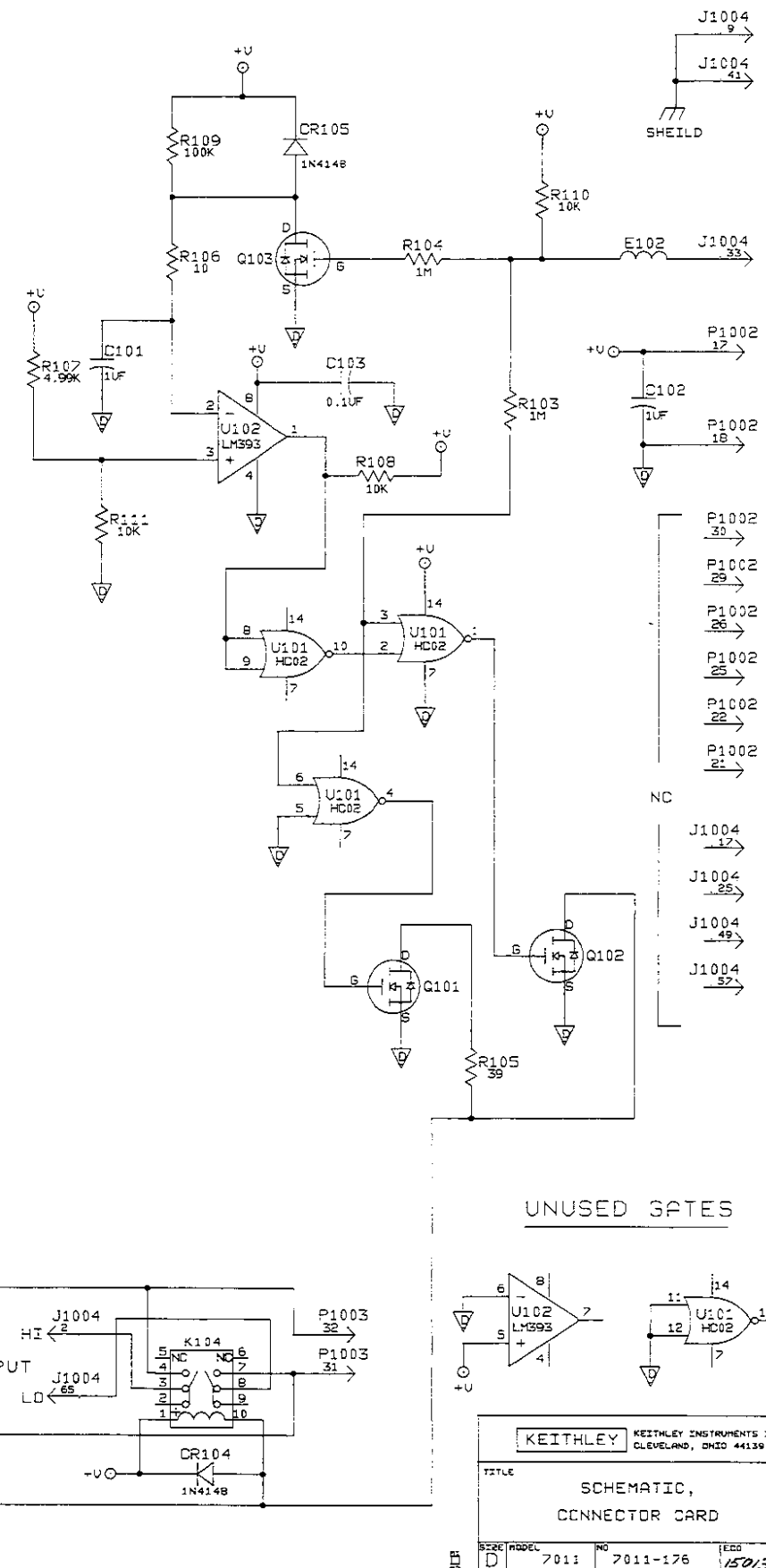
BANK C

IN 1	HI	J1004 80	P1003 26
	LO	J1004 48	P1003 25
IN 2	HI	J1004 16	P1003 42
	LO	J1004 79	P1003 41
IN 3	HI	J1004 47	P1003 44
	LO	J1004 15	P1003 43
IN 4	HI	J1004 78	P1003 12
	LO	J1004 46	P1003 11
IN 5	HI	J1004 14	P1003 10
	LO	J1004 77	P1003 9
IN 6	HI	J1004 45	P1002 44
	LO	J1004 13	P1002 43
IN 7	HI	J1004 76	P1002 42
	LO	J1004 44	P1002 41
IN 8	HI	J1004 12	P1002 12
	LO	J1004 75	P1002 11
IN 9	HI	J1004 43	P1002 28
	LO	J1004 11	P1002 27
IN 10	HI	J1004 74	P1002 10
	LO	J1004 42	P1002 9

BANK D

IN 1	HI	J1004 72	P1003 30
	LO	J1004 40	P1003 29
IN 2	HI	J1004 8	P1003 46
	LO	J1004 71	P1003 45
IN 3	HI	J1004 39	P1003 48
	LO	J1004 7	P1003 47
IN 4	HI	J1004 70	P1003 16
	LO	J1004 38	P1003 15
IN 5	HI	J1004 6	P1003 14
	LO	J1004 69	P1003 13
IN 6	HI	J1004 37	P1002 48
	LO	J1004 5	P1002 47
IN 7	HI	J1004 68	P1002 46
	LO	J1004 36	P1002 45
IN 8	HI	J1004 4	P1002 16
	LO	J1004 67	P1002 15
IN 9	HI	J1004 35	P1002 32
	LO	J1004 3	P1002 31
IN 10	HI	J1004 66	P1002 14
	LO	J1004 34	P1002 13



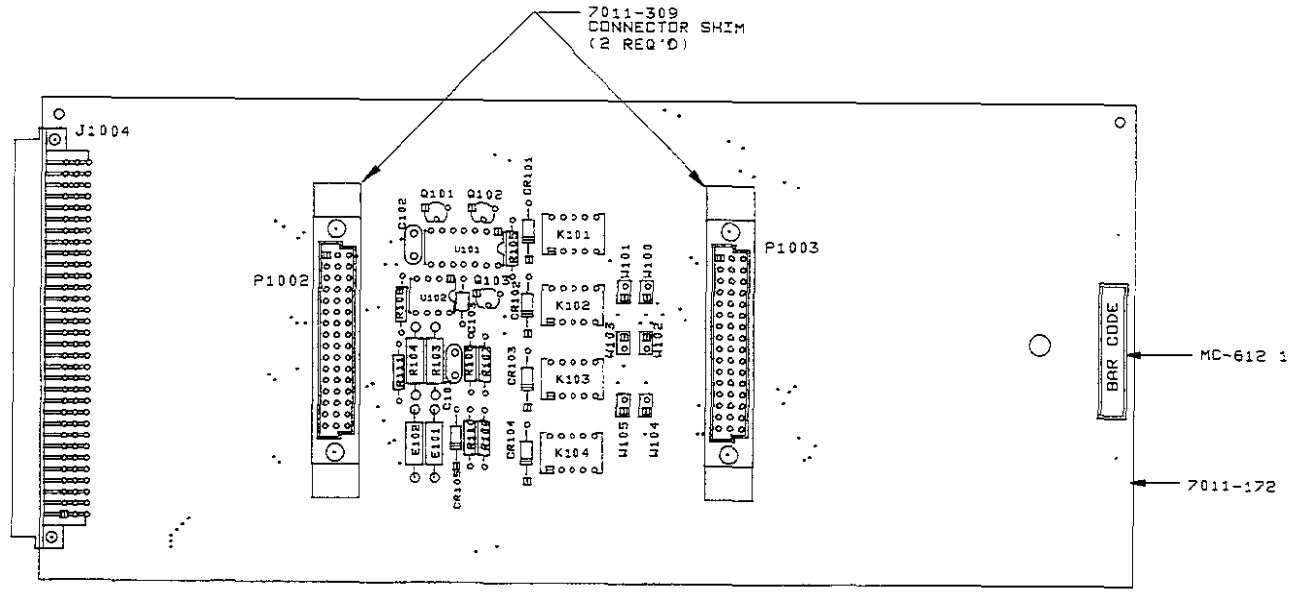


UNUSED GATES

KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139			
TITLE: SCHEMATIC, CONNECTOR CARD				
SIZE: D	MODEL: 7011	NO: 7011-176	ECO: 15013	REV: B
DRAWN: MAH	APPROVED: CJM	DATE: 12/18/91		

NO. 7011-170

LTR.	ECO NO.	REVISION	ENG.	DATE
B	15013	RELEASED		1-2-92



NOTE: FOR COMPONENT INFORMATION
REFER TO PRODUCT STRUCTURE.

MODEL	NEXT ASSEMBLY	QTY.
7011		
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 12/18/91	SCALE 1:1	TITLE	COMPONENT LAYOUT, MASS TERM. CARD
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. MAH	ENG APPR. JM		
	XXX=±.005 FRAC.=±1/64	MATERIAL		C	NO. 7011-170
	SURFACE MAX. 63	FINISH			

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ Analog output follows display
- ❑ Particular range or function bad; specify _____
- ❑ IEEE failure
- ❑ Obvious problem on power-up
- ❑ Batteries and fuses are OK
- ❑ Front panel operational
- ❑ All ranges or functions are bad
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unable to zero
- ❑ Unstable
- ❑ Will not read applied input
- ❑ Overload

- ❑ Calibration only
- ❑ Certificate of calibration required
- ❑ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

KEITHLEY

Keithley Instruments, Inc.
Test Instrumentation Group
28775 Aurora Road
Cleveland, Ohio 44139

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